



WTP Filtration Improvements and Hypochlorite Conversion

60% Submittal

June 2023



CITY OF PITTSBURG
WTP FILTRATION IMPROVEMENTS
AND HYPOCHLORITE CONVERSION
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PUBLIC WORKS CONTRACT DOCUMENTS

This packet includes a complete set of generic front end documents in template form for municipal public works contracts of \$25,000 or more (the threshold for payment and performance bonds) that will be awarded through a formal or informal public bid procedure pursuant to California law. The document preparer should refer to the User Guide that follows for directions on using the following forms:

For the Project Manual:

1. Notice Inviting Bids
2. Instructions to Bidders
3. Bid Proposal
4. Bid Schedule (*optional*)
5. Subcontractor List
6. Noncollusion Declaration
7. Bid Bond
8. Bidder's Questionnaire (*optional*)
9. Contract
10. Payment Bond
11. Performance Bond
12. General Conditions
13. Special Conditions
14. Attachment A – Federal Bidding Requirements (*optional*)
15. Attachment B – Federal Contract Requirements (*optional*)

For City's Internal Use (*Do not include in Project Manual*):

16. Notice of Potential Award
17. Notice to Proceed
18. Notice of Completion

*Note: These documents are frequently updated. To ensure you have the latest version from Jarvis, Fay & Gibson, please email Christina Lawrence at clawrence@jarvisfay.com.
(Revised 12/30/21)*

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PUBLIC WORKS CONTRACT DOCUMENTS USER GUIDE

For internal use only: Do not include in Project Manual

This front end template consists of bid and contract documents (Division 00 documents) which are designed to be compatible with most technical specifications for horizontal or vertical projects that require informal or formal bidding, and payment and performance bonds. Each document is designed to work with the others, with defined terms used consistently throughout.

Prompts: Some of the documents include blanks for the City to complete and may also include written prompts for filling in those blanks, between angle brackets (< >). All such prompts and angle brackets are intended solely to assist the document preparer and should be deleted from the final form for each project.

Optional Provisions: Some of the documents include optional provisions that may be copied and pasted in as needed or deleted if not needed for a particular project. Where applicable, instructions for the completion or use of particular provisions are provided in *italics and highlighted* so that the instructions can easily be distinguished from the text and deleted as the documents are completed for use.

Conventions: Numbers one through ten are generally stated in words, except when used with the percent (%) symbol or for section references. Numbers 11 and greater are stated as numerals. Defined terms and document titles are capitalized. Dollar amounts are stated numerically only, and not spelled out in words. The most frequently used defined terms are defined in Article 1 of the General Conditions; other definitions are provided directly in the relevant text.

Internal Use Documents: Most of the documents in this template are intended for inclusion in a project manual as the front end documents. The remaining four documents, including this User Guide, are provided for internal use. Do not include them or the template cover page in the project manual.

Document Preparation: Document preparers are advised to carefully follow the directions in this User Guide and those included within each document. Use “Show ¶” view when editing to avoid inadvertent deletion of page or section breaks, especially when cutting or deleting optional provisions. Delete this User Guide and any “internal use” documents from the completed bid packet. Brief directions for each document follow:

Cover Pages:

- Insert the City’s customary cover page(s) as indicated.
- The map page is optional. Copy a map or diagram showing the project location on the map page or delete the map page.

Footers:

- Enter the project title and project number as indicated for each document.

Note: Check the version date in the center of the footer to ensure the most current version of the template is being used.

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Table of Contents:

- Make sure all edits have been completed in the body of this document before making changes to the Table of Contents.
- Once the documents have been prepared, update the Table of Contents by right-clicking anywhere inside the Table of Contents and then clicking “Update Field.” Formatting may need to be adjusted following the update. The Table of Contents does not include the template documents that are intended for internal use only, i.e., the Notice of Potential Award, Notice to Proceed, Notice of Completion and this User Guide, or documents that are not included within this template, such as the Technical Specifications.

Notice Inviting Bids:

- This form should be completed as indicated and used to give public notice as required for formal or informal bids by the Public Contract Code. It primarily includes provisions that are required by law to be included in the notice inviting bids. To limit publication costs, provisions that are not required for the notice are in the Instructions to Bidders.
- For Section 2.1, provide a summary description of the work including significant components. Descriptions of magnitude may be helpful, e.g., “installation of 12,000 linear feet of 18-inch waterline” or “placement of 1,000 tons of asphalt.”
- Section 2.2 is intended to be flexible. For example, this provision could specify that the project must be completed within a specific number of calendar or working days after issuance of the Notice to Proceed, or it could specify that the project must be completed by a specific calendar date.
- For Section 3.1, provide the applicable license classification(s) required for the project. For further information see http://www.cslb.ca.gov/About_Us/Library/Licensing_Classifications/.
- Section 4 should be adapted based on how the City will make the contract documents, including plans and specifications, available for bidders.
- For projects that may be awarded through informal bidding requirements under Public Contract Code § 22034, where the Notice is transmitted to qualified contractors (instead of publication or posting), the final line for the publication date may be deleted. Informal bidding under § 22034 only applies to agencies that have elected to adopt the California Uniform Construction Cost Accounting Procedures.
- The Optional Provisions that follow should be completed, copied and pasted in as directed—*if applicable*. Delete the instructions and all unused optional provisions.

Instructions to Bidders:

- This form should be completed as indicated to provide clear instructions and information to the bidders. It may be tailored to include project-specific bidding requirements and procedures.
- The initial paragraph at the top of page should be completed with the project title.

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- Regarding Section 1.3, the DIR advises that public agencies must confirm a bidder's DIR registration before the sealed bid is opened. The DIR registration number is required on the outside of the sealed envelope so that it can be verified on the DIR's website before the bid is opened. *Exceptions:* The City may accept bids from unregistered contractors for contracts authorized under B&P § 7029.1 (joint ventures), or PCC § 20103.5 (federally funded); however, even for those exceptions, the contractor must be registered at the time the contract is awarded. (Labor Code § 1771.1(a).)
- Complete Sections 1.2, 5, 8, 10, and 13 as indicated.
- The Optional Provisions that follow should be completed, copied and pasted in as directed—if *applicable*. Delete all of the remaining optional provisions and instructions.

Bid Proposal:

- Add the project title and add/complete or delete the Optional Provision as applicable. Delete the instructions and unused provisions.
- The rest of the form should be completed and submitted by the bidder as indicated.

Bid Schedule (Optional):

- The optional Bid Schedule form is provided primarily for horizontal projects. If a Bid Schedule is required, make sure to include the optional "Bid Schedule" provision in the Instructions to Bidders. If needed, adapt the Bid Schedule for separate bid alternates, the amount of which must be listed separately from the Base Bid amount.
- Complete as appropriate to indicate the unit pricing required for the project.
- Mark any item intended as a "Final Pay Quantity" with an asterisk (*).

Note: If the project includes construction of a pipeline, sewer, sewage disposal system, boring and jacking pits, or similar trenches or open excavations, which are five feet or deeper, the Bid Schedule should include a bid item for adequate sheeting, shoring, and bracing, or equivalent method, for the protection of life or limb, as required by Labor Code § 6707.

Subcontractor List:

- This form must be completed by each bidder as indicated and submitted with the bid, if applicable.

Noncollusion Declaration:

- This form must be completed by each bidder as indicated and submitted with the bid.

Bid Bond:

- This form must be completed and submitted by each bidder that is using a bid bond as bid security. Enter the project title and city name as indicated.

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Bidder's Questionnaire (Optional):

- This optional document may be included in the bid packet if the City wants additional background information on the bidders before awarding the bid. Information obtained from using this optional questionnaire may be useful for determining whether a low bidder appears to be "responsible." In order to avoid bid protests over qualifications submittals, this template is structured for requiring the low or lowest bidder(s) to provide the questionnaire upon request after bids are opened.
- Enter the project title at the top of the page. Section 5.3 may be modified to elicit more specific information about a bidder's experience relative to the specific project to be performed.
- Whenever the Bidder's Questionnaire is required, make sure to include the optional "Bidder's Questionnaire" provision in the Instructions to Bidders.
- This form is not required by law and should not be used for any project for which bidders are required to be prequalified. A statutorily-compliant process should be used for prequalification.

Contract:

- This form should be partially completed by the City *before* inclusion in the bid packet, by adding the name of the project in the top paragraph, and by completing Sections 2 (list additional documents, if any), Section 5 (Time for Completion), Section 6 (Liquidated Damages), Section 11 (the City's portion of notice), and Section 12.3 (Governing Law and Venue) as indicated.

Note: Liquidated damages should be determined on a project-by-project basis based upon foreseeable damage from delay. Foreseeable damage may include extended costs of inspection or other consultant services, cost to rent or provide alternative facilities, and public inconvenience. Because foreseeable damages will vary depending on circumstances, it is not advisable to use a single flat rate for all projects or to base the amount on a percentage of the contract price.

- It is critical that the list in Section 2, Contract Documents, is complete and accurate. For federally funded projects administered under the Local Assistance Procedures Manual, be sure to list Attachment A – Federal Bidding Requirements and Attachment B – Federal Contract Requirements. Do not include documents, e.g., technical reports that are provided "For Reference Only." See optional provision for the Instructions to Bidders, on "For Reference Only."
- Section 5 is structured so that the Contract Time is determined by calendar days because this approach is simpler, more precise, and less likely to give rise to disputes.
- Prior to awarding the Contract to the responsive and responsible low bidder, complete Section 4, Payment (contract price), before attaching the Contract to the Notice of Potential Award, which will be completed and executed by the Contractor in the number of originals required by the City.
- The City should not execute the Contract until the City has received, reviewed, and approved the executed Contract from the Contractor along with its payment and

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performance bonds and certificates of insurance. Assuming all of those items are in order, following award, complete Section 1, Award of Contract, and have the Contract executed by the City's authorized representatives.

Note: Be sure to carefully review the signed Contract submitted by the Contractor to ensure it has been completed and signed as required, and to ensure no improper changes have been made, such as to the Contract amount, liquidated damages amount, or time for completion.

Payment Bond:

- Enter the project title as indicated. This form must be completed and executed as indicated and returned by the Contractor.

Note: Payment bonds are required for any public works project of \$25,000 or more.

Performance Bond:

- Enter the project title as indicated. This form must be completed and executed as indicated and returned by the Contractor.

General Conditions:

- The General Conditions are, as the title indicates, *general*, and include many provisions that are required by law as well as customary contractual requirements. They are drafted to be used for any municipal public works project and ***should not be modified without consulting with an experienced attorney***. Project-specific information and requirements should be in the Special Conditions and the Technical Specifications.
- The default insurance limits included in Section 4.3(A) (e.g., \$2,000,000 per occurrence and \$4,000,000 general aggregate for commercial general liability insurance) may be increased or decreased depending on the nature of the project and commensurate risk. Risk does not necessarily correlate to contract price—a small job can involve greater risk than a larger project, depending on the specific circumstances. Certain large projects may also require much higher limits. The builder's risk insurance included under Section 4.3(A)(5) may not be required for horizontal projects. Changes to the insurance coverage requirements and default limits under Section 4.3 should be reflected in the Special Conditions for that contract, using the optional provision provided for that purpose, subject to approval of the City's Risk Manager.
- Section 6.3(C), Time and Materials, includes default percentages for markup. The percentages are not set by law and may be modified.

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Special Conditions:

- The Special Conditions are intended to include project-specific provisions that modify or supplement the General Conditions. Technical specifications, including Division 01 documents, should not be included in the Special Conditions, but rather in the Technical Specifications prepared for the Project.
- The Special Conditions form includes a very limited cut-and-paste “menu” of Optional Provisions to add to the project Special Conditions. Any optional provision that is not applicable should be deleted, along with the instructions (in *italics and highlighted*) when preparing the Special Conditions for the particular project.
- Additional provisions for the Special Conditions should be added by the City on a per project basis, including requirements for state or federally funded projects. To ensure consistency, any added provisions should be adapted to use the same defined terms that are provided in Article 1 of the General Conditions.

Note: The Special Conditions take precedence over the General Conditions, so it is advisable to request legal review of the draft Special Conditions before they are released, to ensure that they conform to legal requirements and do not unintentionally conflict with the other Contract Documents.

Attachment A – Federal Bidding Requirements (Optional):

- This is an optional placeholder that may be used for federally-funded projects administered under Caltrans’ Local Assistance Procedures Manual (“LAPM”) to attach and incorporate federal bidding requirements and federal bid forms as specified in the LAPM. The document preparer should consult the current LAPM and funding administrator or consultant as needed to determine which LAPM exhibits should be attached. **Delete Attachment A if not applicable.** The LAPM may be downloaded from: <https://dot.ca.gov/programs/local-assistance/guidelines-and-procedures/local-assistance-procedures-manual-lapm>.

Attachment B – Federal Contract Requirements (Optional):

- This is an optional placeholder that may be used for federally-funded projects administered under Caltrans’ LAPM to attach and incorporate federal contract requirements and forms as specified in the LAPM. The document preparer should consult the current LAPM and funding administrator or consultant as needed to determine which LAPM exhibits should be attached. **Delete Attachment B if not applicable.** The LAPM may be downloaded from: <https://dot.ca.gov/programs/local-assistance/guidelines-and-procedures/local-assistance-procedures-manual-lapm>.

Notice of Potential Award:

- This form letter should be completed by the City as indicated and sent to the selected Contractor, and should enclose a copy of the Contract (completed with the bid price) for execution and return by the Contractor. This form is provided for internal use, and should not be included in the Project Manual.

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Note: Public agencies must notify the DIR of award of a public works contract online at <https://www.dir.ca.gov/pwc100ext/> within 30 days of award, but no later than the first day that work is to begin.

Notice to Proceed:

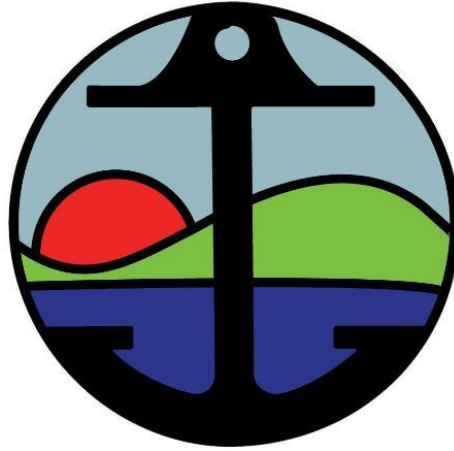
- This form letter should be completed by the City as indicated and sent to the Contractor after the City has countersigned the executed Contract and is prepared to direct the Contractor to proceed with the work. This form is provided for internal use and should not be included in the Project Manual.
- The Notice to Proceed includes an optional provision in brackets [] that may be used to schedule a pre-construction conference. Complete as indicated or delete if inapplicable.

Notice of Completion:

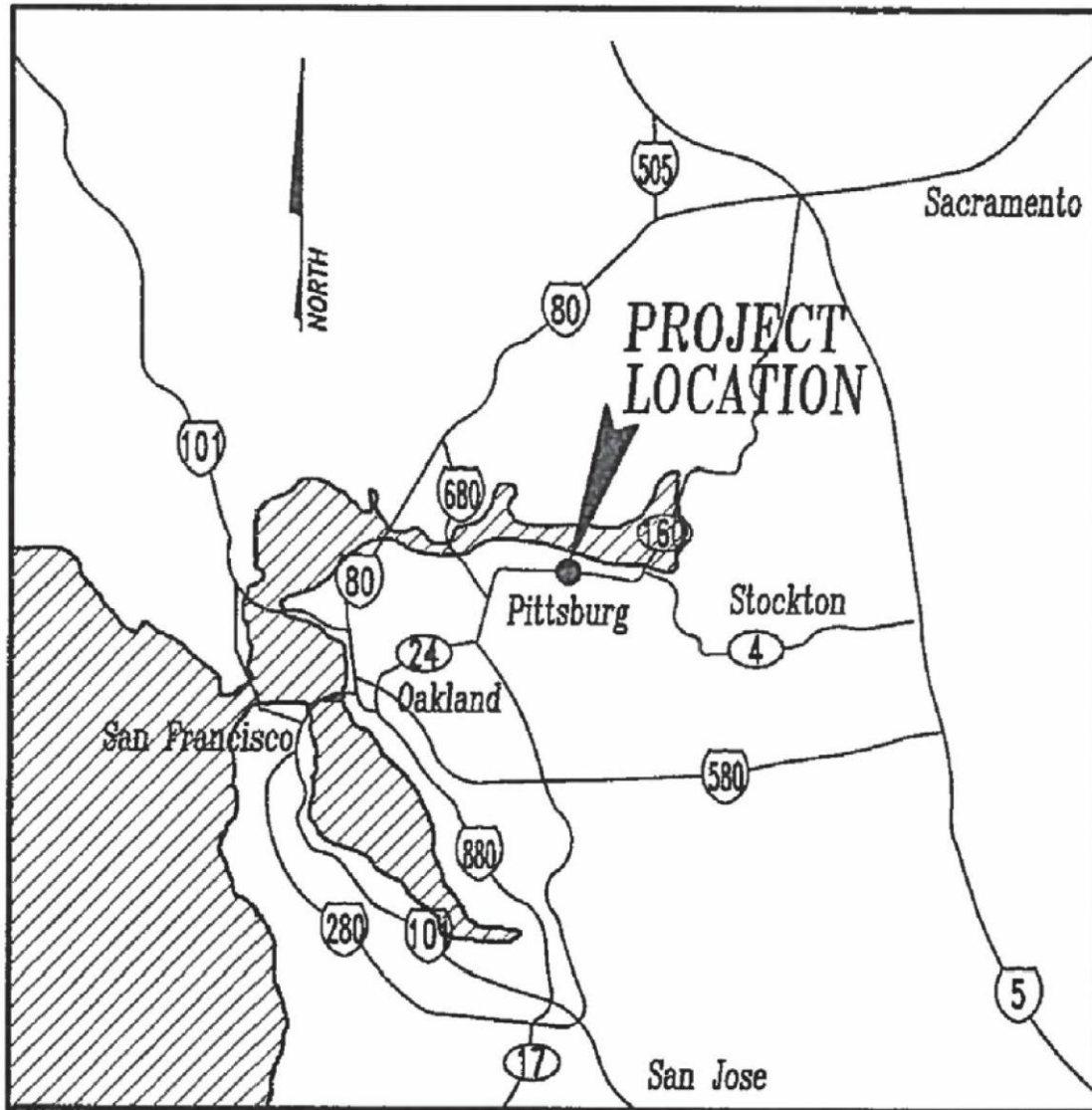
- This form should be completed by the City as indicated and should be recorded no later than 15 days after the Project has been formally accepted as complete (even if acceptance is subject to exceptions for incomplete minor punch list items). This form is provided for internal use, and should not be included in the Project Manual.

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**CITY STANDARD SPECIFICATIONS
JULY 2022**



CITY OF PITTSBURG, CALIFORNIA



VICINITY MAP

1" = 20 Miles



MEASURES 3-INCHES ON ORIGINAL



**CITY OF
PITTSBURG**

NO.	DATE	REVISION	DRAWN BY: AP
			CHECKED BY: AP
			DATE: 3/13/2019
			SCALE: NOTED

VICINITY MAP

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33 13 00 Disinfecting of Water Distribution
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33 41 13 Storm Drainage Piping

DIVISION 34 – TRANSPORTATION

34 41 00 Traffic Control Signals and Lighting
34 41 05 Traffic Signage

Notice Inviting Bids

1. **Bid Submission.** <_____> (“City”) will accept sealed bids for its <_____> Project (“Project”), by or before <_____>, 20<__>, at <_____>:<_____> <__>.m., at its <_____> office, located at <_____>, California, at which time the bids will be publicly opened and read aloud.
2. **Project Information.**
 - 2.1 **Location and Description.** The Project is located at _____, _____ <Project location>, and is described as follows: <Insert summary description of the Project>

 - 2.2 **Time for Final Completion.** The Project must be fully completed within <__> calendar days from the start date set forth in the Notice to Proceed. City anticipates that the Work will begin on or about <_____>, but the anticipated start date is provided solely for convenience and is neither certain nor binding.
3. **License and Registration Requirements.**
 - 3.1 **License.** This Project requires a valid California contractor’s license for the following classification(s): <_____>.
 - 3.2 **DIR Registration.** City may not accept a Bid Proposal from or enter into the Contract with a bidder, without proof that the bidder is registered with the California Department of Industrial Relations (“DIR”) to perform public work pursuant to Labor Code § 1725.5, subject to limited legal exceptions.
4. **Contract Documents.** The plans, specifications, bid forms and contract documents for the Project, and any addenda thereto (“Contract Documents”) may be downloaded from City’s website located at: http://www.<_____>. A printed copy of the Contract Documents are <not available> **OR** <may be obtained from> _____<Name>, _____<Title>, at _____<U.S. Mail or Email Address>, for a nonrefundable payment to City of \$ <_____>.
5. **Bid Security.** The Bid Proposal must be accompanied by bid security of ten percent of the maximum bid amount, in the form of a cashier’s or certified check made payable to City, or a bid bond executed by a surety licensed to do business in the State of California on the Bid Bond form included with the Contract Documents. The bid security must guarantee that within ten days after City issues the Notice of Potential Award, the successful bidder will execute the Contract and submit the payment and performance bonds, insurance certificates and endorsements, and any other submittals required by the Contract Documents and as specified in the Notice of Potential Award.
6. **Prevailing Wage Requirements.**
 - 6.1 **General.** Pursuant to California Labor Code § 1720 et seq., this Project is subject to the prevailing wage requirements applicable to the locality in which the Work is to be performed for each craft, classification or type of worker needed to perform

the Work, including employer payments for health and welfare, pension, vacation, apprenticeship and similar purposes.

- 6.2 Rates.** The prevailing rates are on file with the City and are available online at <http://www.dir.ca.gov/DLSR>. Each Contractor and Subcontractor must pay no less than the specified rates to all workers employed to work on the Project. The schedule of per diem wages is based upon a working day of eight hours. The rate for holiday and overtime work must be at least time and one-half.
- 6.3 Compliance.** The Contract will be subject to compliance monitoring and enforcement by the DIR, under Labor Code § 1771.4.
- 7. Performance and Payment Bonds.** The successful bidder will be required to provide performance and payment bonds, each for 100% of the Contract Price, as further specified in the Contract Documents.
- 8. Substitution of Securities.** Substitution of appropriate securities in lieu of retention amounts from progress payments is permitted under Public Contract Code § 22300.
- 9. Subcontractor List.** Each Subcontractor must be registered with the DIR to perform work on public projects. Each bidder must submit a completed Subcontractor List form with its Bid Proposal, including the name, location of the place of business, California contractor license number, DIR registration number, and percentage of the Work to be performed (based on the base bid price) for each Subcontractor that will perform Work or service or fabricate or install Work for the prime contractor in excess of one-half of 1% of the bid price, using the Subcontractor List form included with the Contract Documents.
- 10. Instructions to Bidders.** All bidders should carefully review the Instructions to Bidders for more detailed information before submitting a Bid Proposal. The definitions provided in Article 1 of the General Conditions apply to all of the Contract Documents, as defined therein, including this Notice Inviting Bids.

By: _____ Date: _____

<_____,> City Engineer

Publication Date: <_____>

END OF NOTICE INVITING BIDS

Optional Provisions for Notice Inviting Bids:

*The following optional provisions should be added to the Notice Inviting Bids only if applicable. Applicable provisions may be copied and pasted immediately following item 10 on the standard Notice Inviting Bids form, numbered accordingly, and completed if needed. **Delete instructions and notes (in italics) and unused optional provisions.***

The following provision should be completed as indicated and added to the Notice Inviting Bids if a bidders' conference or site visit is scheduled. If used for a site visit, replace each use of the term "bidders' conference" with "site visit."

- ___ **Bidders' Conference.** A bidders' conference will be held on <_____>, 20<____> at <____>:<____> <__>.m., at the following location: <_____> to acquaint all prospective bidders with the Contract Documents and the Worksite. The bidders' conference is <___/ is not ____> mandatory. A bidder who fails to attend a mandatory bidders' conference may be disqualified from bidding.

*Note: Public Contract Code § 6610 prohibits any **mandatory** pre-bid conference, site visit, or meeting from taking place sooner than five days after the Notice Inviting Bids is published for the first time.*

The following provision may be completed as indicated and added to the end of Section 2 of the Notice Inviting Bids if the City wishes to inform bidders of the estimated construction cost. Alternatively, this could be added to the end of Instructions to Bidders and re-numbered to fit.

- 2.3 Estimated Cost.** The estimated construction cost is \$<_____>.

Note: Government Code §§ 4003-4004 require that the City Engineer maintain an estimate of the Project costs on file in his/her office.

The following provision should be completed as indicated and added to the Notice Inviting Bids if bidders are required to be prequalified.

- ___ **Prequalification.** Only bids from prequalified bidders will be accepted. Prequalification forms and requirements are available at <_____>, and completed prequalification packets must be submitted to <_____> at <_____> by <____>:<__> <__>.m., on <____>, 20<____>.

Note: If prequalification is not required for the Project, the City may wish to require submission of the Bidder's Questionnaire with the bid in order to obtain additional information on each bidder and its past projects. An optional Bidder's Questionnaire is included with the Public Works Contract Documents, and instructions regarding submission of the Bidder's Questionnaire are included in the Optional Provisions for the Instructions to Bidders.

The following provision should be completed as indicated and added to the Notice Inviting Bids if, and only if, the City Council or its designee has made a finding that a particular material, product, thing, or service is designated by specific brand or trade for one of the purposes permitted under subdivision (c) of Public Contract Code § 3400. For each item specified, indicate the statutory basis for the finding under "Reference," e.g., § 3400(c)(1), (c)(2), (c)(3) or (c)(4), as applicable per note below.

___ **Specific Brands.** Pursuant to referenced provision(s) of Public Contract Code § 3400(c), City has found that the following specific brands are required for the following particular material(s), product(s), thing(s), or service(s), and no substitutions will be considered or accepted:

Item:	Required brand:	Reference:
_____	_____	_____
_____	_____	_____
_____	_____	_____

Note: Under Public Contract Code § 3400(c), a sole source specification is only permitted as follows:

- (c)(1) required for field testing or experiment;
- (c)(2) required to match products in use for the improvement;
- (c)(3) a necessary item that is only available from one source; or
- (c)(4) required to respond to a state-declared emergency.

The following provision should be completed as indicated and added to the Notice Inviting Bids for any Project that has been determined to be "substantially complex" in accordance with Public Contract Code § 7201, and is therefore subject to a retention rate in excess of the 5% cap. A finding of substantial complexity must be made during a public hearing by the City Council or its designee on a project by project basis, and the finding must include a description of the specific project and explain "why it is a unique project that is not regularly, customarily, or routinely performed by the agency or licensed contractors." In addition, the bid documents must include "details explaining the basis for the finding." At a minimum, the explanation made to support the finding should be included as indicated below to satisfy the requirement to provide "details explaining the basis for the finding" in the bid documents.

___ **Retention.**

___**.1 Substantial Complexity.** The City Council or its designee has approved a finding under Public Contract Code § 7201 that this Project is substantially complex and therefore requires a retention amount higher than 5%.

___**.2 Basis for Finding.** The basis for the finding that this is a unique project that is not regularly, customarily, or routinely performed by City or by licensed contractors is as follows:
 _____ <provide basis for finding>.

___**.3 Percentage.** The percentage of retention that will be withheld from progress payments is < _____ > %.

*The following optional provision may be used for projects administered under Caltrans' Local Assistance Procedures Manual ("LAPM") to (1) attach and incorporate bid provisions and forms for projects administered under the LAPM, as specified in Chapter 12 of the LAPM and exhibits thereto, and (2) incorporate the specific assurance required by the Standard Title VI/Non-Discrimination Assurances under Department of Transportation Order No. 1050.2A. **DELETE ATTACHMENT A IF NOT APPLICABLE.** Be sure to use the most current version of the LAPM and applicable exhibits, which may be downloaded from: <https://dot.ca.gov/programs/local-assistance/guidelines-and-procedures/local-assistance-procedures-manual-lapm>.*

- ___ **Caltrans Administered Project.** This Project is funded in whole or in part by federal funds administered under Caltrans' Local Assistance Procedures Manual ("LAPM").
- ___**.1 Federal Bidding Requirements.** LAPM bidding requirements and forms are provided in Attachment A - Federal Bidding Requirements. Each bidder must comply with the requirements set forth in Attachment A, including completion and submission of required federal forms with its Bid Proposal, as further specified in Attachment A.
- ___**.2 Title VI Non-Discrimination Assurances.** The City, in accordance with the provisions of Title VI of the Civil Rights Act of 1964 (78 Stat. 252, 42 U.S.C. § 2000d et seq.) and applicable regulations, including 49 CFR Part 21, 28 CFR § 50.3, and any other applicable statutory or regulatory authorities identified in the Standard Title VI/Non-Discrimination Assurances, hereby notifies all bidders that it will affirmatively ensure that in any contract entered into pursuant to this advertisement, disadvantaged business enterprises will be afforded full and fair opportunity to submit bids in response to this invitation and will not be discriminated against on the grounds of race, color, or national origin in consideration for an award. Any contract entered into pursuant to this advertisement will be subject to Appendix E of the Title VI Assurances, a copy of which is included in Attachment B - Federal Contract Requirements.
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Instructions to Bidders

Each Bid Proposal submitted to <_____> (“City”) for its <_____> Project (“Project”) must be submitted in accordance with the following instructions and requirements:

1. Bid Submission.

- 1.1 General.** Each Bid Proposal must be signed, sealed and submitted to City, using the form provided in the Contract Documents, by or before the date and time set forth in Section 1 of the Notice Inviting Bids, or as amended by subsequent addendum. Faxed or emailed Bid Proposals will not be accepted, unless otherwise specified. Late submissions will be returned unopened. City reserves the right to postpone the date or time for receiving or opening bids. Each bidder is solely responsible for all of its costs to prepare and submit its bid and by submitting a bid waives any right to recover those costs from City. The bid price(s) must include all costs to perform the Work as specified, including all labor, material, supplies, and equipment and all other direct or indirect costs such as applicable taxes, insurance and overhead.
- 1.2 Bid Envelope.** The envelope containing the sealed Bid Proposal and all required forms and attachments must be clearly labeled and addressed as follows:

BID PROPOSAL:

<_____> Project
Contract No. <_____>

City Clerk
<street address>
<city, state, zip code>
Attn: <_____>

The envelope must also be clearly labeled, as follows, with the bidder’s name, address, and its registration number with the California Department of Industrial Relations (“DIR”) for bidding on public works contracts (Labor Code §§ 1725.5 and 1771.1):

[Contractor company name]
[street address]
[city, state, zip code]
DIR Registration No: _____

- 1.3 DIR Registration.** Subject to limited legal exceptions for joint venture bids and federally-funded projects, City may not accept a Bid Proposal from a bidder without proof that the bidder is registered with the DIR to perform public work under Labor Code § 1725.5. If City is unable to confirm that the bidder is currently registered with the DIR, City may disqualify the bidder and return its bid unopened. (Labor Code §§ 1725.5 and 1771.1(a).)
- 2. Bid Proposal Form and Enclosures.** Each Bid Proposal must be completed in ink using the Bid Proposal form included with the Contract Documents. The Bid Proposal form must be fully completed without interlineations, alterations, or erasures. Any necessary corrections must be clear and legible, and must be initialed by the bidder’s authorized representative. A Bid Proposal submitted with exceptions or terms such as “negotiable,”

“will negotiate,” or similar, will be considered nonresponsive. Each Bid Proposal must be accompanied by bid security, as set forth in Section 4 below, and by a completed Subcontractor List and Non-Collusion Declaration using the forms included with the Contract Documents, and any other required enclosures, as applicable.

3. **Authorization and Execution.** Each Bid Proposal must be signed by the bidder’s authorized representative. A Bid Proposal submitted by a partnership must be signed in the partnership name by a general partner with authority to bind the partnership. A Bid Proposal submitted by a corporation must be signed with the legal name of the corporation, followed by the signature and title of two officers of the corporation with full authority to bind the corporation to the terms of the Bid Proposal, under California Corporations Code § 313.
4. **Bid Security.** Each Bid Proposal must be accompanied by bid security of ten percent of the maximum bid amount, in the form of a cashier’s check or certified check, made payable to the City, or bid bond using the form included in the Contract Documents and executed by a surety licensed to do business in the State of California. The bid security must guarantee that, within ten days after issuance of the Notice of Potential Award, the bidder will: execute and submit the enclosed Contract for the bid price; submit payment and performance bonds for 100% of the maximum Contract Price; and submit the insurance certificates and endorsements and any other submittals, if any, required by the Contract Documents or the Notice of Potential Award. A Bid Proposal may not be withdrawn for a period of 60 days after the bid opening without forfeiture of the bid security, except as authorized for material error under Public Contract Code § 5100 et seq.
5. **Requests for Information.** Questions or requests for clarifications regarding the Project, the bid procedures, or any of the Contract Documents must be submitted in writing to _____ <Name>, _____ <Title>, at _____ <Email Address>. Oral responses are not authorized and are not binding on the City. Bidders should submit any such written inquiries at least five Working Days before the scheduled bid opening. Questions received any later might not be addressed before the bid deadline. An interpretation or clarification by City in response to a written inquiry will be issued in an addendum.
6. **Pre-Bid Investigation.**
 - 6.1 **General.** Each bidder is solely responsible at its sole expense for diligent and thorough review of the Contract Documents, examination of the Project site, and reasonable and prudent inquiry concerning known and potential site and area conditions prior to submitting a Bid Proposal. Each bidder is responsible for knowledge of conditions and requirements which reasonable review and investigation would have disclosed. However, except for any areas that are open to the public at large, bidders may not enter property owned or leased by the City or the Project site without prior written authorization from City.
 - 6.2 **Document Review.** Each bidder is responsible for review of the Contract Documents and any informational documents provided “For Reference Only,” e.g., as-builts, technical reports, test data, and the like. A bidder is responsible for notifying City of any errors, omissions, inconsistencies, or conflicts it discovers in the Contract Documents, acting solely in its capacity as a contractor and subject to the limitations of Public Contract Code § 1104. Notification of any such errors, omissions, inconsistencies, or conflicts must be submitted in writing to the City no later than five Working Days before the scheduled bid opening. (See Section 5, above.) City expressly disclaims responsibility for assumptions a bidder might draw from the presence or absence of information provided by City.

6.3 Project Site. Questions regarding the availability of soil test data, water table elevations, and the like should be submitted to the City in writing, as specified in Section 5, above. Any subsurface exploration at the Project site must be done at the bidder's expense, but only with prior written authorization from City. All soil data and analyses available for inspection or provided in the Contract Documents apply only to the test hole locations. Any water table elevation indicated by a soil test report existed on the date the test hole was drilled. The bidder is responsible for determining and allowing for any differing soil or water table conditions during construction. Because groundwater levels may fluctuate, difference(s) in elevation between ground water shown in soil boring logs and ground water actually encountered during Project construction will not be considered changed Project site conditions. Actual locations and depths must be determined by bidder's field investigation. The bidder may request access to underlying or background information on the Project site in City's possession that is necessary for the bidder to form its own conclusions, including, if available, record drawings or other documents indicating the location of subsurface lines, utilities, or other structures.

6.4 Utility Company Standards. The Project must be completed in a manner that satisfies the standards and requirements of any affected utility companies or agencies (collectively, "utility owners"). The successful bidder may be required by the third party utility owners to provide detailed plans prepared by a California registered civil engineer showing the necessary temporary support of the utilities during coordinated construction work. Bidders are directed to contact the affected third party utility owners about their requirements before submitting a Bid Proposal.

7. Bidders Interested in More Than One Bid. No person, firm, or corporation may submit or be a party to more than one Bid Proposal unless alternate bids are specifically called for. However, a person, firm, or corporation that has submitted a subcontract proposal or quote to a bidder may submit subcontract proposals or quotes to other bidders.

8. Addenda. Any addenda issued prior to the bid opening are part of the Contract Documents. Subject to the limitations of Public Contract Code § 4104.5, City reserves the right to issue addenda prior to bid time. Each bidder is solely responsible for ensuring it has received and reviewed all addenda prior to submitting its bid. Bidders should check City's website periodically for any addenda or updates on the Project at: <http://www.< >>.

9. Brand Designations and "Or Equal" Substitutions. Any specification designating a material, product, thing, or service by specific brand or trade name, followed by the words "or equal," is intended only to indicate quality and type of item desired, and bidders may request use of any equal material, product, thing, or service. All data substantiating the proposed substitute as an equal item must be submitted with the written request for substitution. A request for substitution must be submitted within 35 days after Notice of Potential Award unless otherwise provided in the Contract Documents. This provision does not apply to materials, products, things, or services that may lawfully be designated by a specific brand or trade name under Public Contract Code § 3400(c).

10. Bid Protest. Any bid protest against another bidder must be submitted in writing and received by City at _____<Address> or sent via email at _____<Email Address> before 5:00 p.m. no later than two Working Days following bid opening ("Bid Protest Deadline") and must comply with the following requirements:

10.1 General. Only a bidder who has actually submitted a Bid Proposal is eligible to submit a bid protest against another bidder. Subcontractors are not eligible to

submit bid protests. A bidder may not rely on the bid protest submitted by another bidder, but must timely pursue its own protest. If required by City, the protesting bidder must submit a non-refundable fee in the amount specified by City, based upon City's reasonable costs to administer the bid protest. Any such fee must be submitted to City no later than the Bid Protest Deadline, unless otherwise specified. For purposes of this Section 10, a "Working Day" means a day that City is open for normal business, and excludes weekends and holidays observed by City. Pursuant to Public Contract Code § 4104, inadvertent omission of a Subcontractor's DIR registration number on the Subcontractor List form is not grounds for a bid protest, provided it is corrected within 24 hours of the bid opening or as otherwise provided under Labor Code § 1771.1(b).

- 10.2 Protest Contents.** The bid protest must contain a complete statement of the basis for the protest and must include all supporting documentation. Material submitted after the Bid Protest Deadline will not be considered. The protest must refer to the *specific* portion or portions of the Contract Documents upon which the protest is based. The protest must include the name, address, email address, and telephone number of the protesting bidder and any person submitting the protest on behalf of or as an authorized representative of the protesting bidder.
- 10.3 Copy to Protested Bidder.** Upon submission of its bid protest to City, the protesting bidder must also concurrently transmit the protest and all supporting documents to the protested bidder, and to any other bidder who has a reasonable prospect of receiving an award depending upon the outcome of the protest, by email or hand delivery to ensure delivery before the Bid Protest Deadline.
- 10.4 Response to Protest.** The protested bidder may submit a written response to the protest, provided the response is received by City before 5:00 p.m., within two Working Days after the Bid Protest Deadline or after actual receipt of the bid protest, whichever is sooner (the "Response Deadline"). The response must attach all supporting documentation. Material submitted after the Response Deadline will not be considered. The response must include the name, address, email address, and telephone number of the person responding on behalf of or representing the protested bidder if different from the protested bidder.
- 10.5 Copy to Protesting Bidder.** Upon submission of its response to the bid protest to the City, the protested bidder must also concurrently transmit by email or hand delivery, by or before the Response Deadline, a copy of its response and all supporting documents to the protesting bidder and to any other bidder who has a reasonable prospect of receiving an award depending upon the outcome of the protest.
- 10.6 Exclusive Remedy.** The procedure and time limits set forth in this Section are mandatory and are the bidder's sole and exclusive remedy in the event of a bid protest. A bidder's failure to comply with these procedures will constitute a waiver of any right to further pursue a bid protest, including filing a Government Code Claim or initiation of legal proceedings.
- 10.7 Right to Award.** City reserves the right, acting in its sole discretion, to reject any bid protest that it determines lacks merit, to award the Contract to the bidder it has determined to be the responsible bidder submitting the lowest responsive bid, and to issue a Notice to Proceed with the Work notwithstanding any pending or continuing challenge to its determination.

11. **Reservation of Rights.** City reserves the unfettered right, acting in its sole discretion, to waive or to decline to waive any immaterial bid irregularities; to accept or reject any or all bids; to cancel or reschedule the bid; to postpone or abandon the Project entirely; or to perform all or part of the Work with its own forces. The Contract will be awarded, if at all, within 60 days after opening of bids or as otherwise specified in the Special Conditions, to the responsible bidder that submitted the lowest responsive bid. Any planned start date for the Project represents the City's expectations at the time the Notice Inviting Bids was first issued. City is not bound to issue a Notice to Proceed by or before such planned start date, and it reserves the right to issue the Notice to Proceed when the City determines, in its sole discretion, the appropriate time for commencing the Work. The City expressly disclaims responsibility for any assumptions a bidder might draw from the presence or absence of information provided by the City in any form. Each bidder is solely responsible for its costs to prepare and submit a bid, including site investigation costs.
12. **Bonds.** Within ten calendar days following City's issuance of the Notice of Potential Award to the apparent low bidder, the bidder must submit payment and performance bonds to City as specified in the Contract Documents using the bond forms included in the Contract Documents. All required bonds must be calculated on the maximum total Contract Price as awarded, including additive alternates, if applicable.
13. **License(s).** The successful bidder and its Subcontractor(s) must possess the California contractor's license(s) in the classification(s) required by law to perform the Work. The successful bidder must also obtain a City business license within <____> days following City's issuance of the Notice of Potential Award. Subcontractors must also obtain a City business license before performing any Work.
14. **Ineligible Subcontractor.** Any Subcontractor who is ineligible to perform work on a public works project under Labor Code §§ 1777.1 or 1777.7 is prohibited from performing work on the Project.
15. **Safety Orders.** If the Project includes construction of a pipeline, sewer, sewage disposal system, boring and jacking pits, or similar trenches or open excavations, which are five feet or deeper, each bid must include a bid item for adequate sheeting, shoring, and bracing, or equivalent method, for the protection of life or limb, which comply with safety orders as required by Labor Code § 6707.

END OF INSTRUCTIONS TO BIDDERS

Optional Provisions for Instructions to Bidders:

*The following optional provisions should be added to the Instructions to Bidders only if applicable. Applicable provisions may be copied and pasted immediately following Section 15 on the standard Instructions to Bidders form, numbered accordingly, and completed if needed. **Delete instructions (in italics) and unused optional provisions.***

The following provision should be used for the purpose of limiting the amount of Work that may be performed by subcontractors.

- ___ **Subcontractor Work Limits.** The prime contractor must perform at least <___>% of the Work on the Project, calculated as a percentage of the base bid price, with its own forces, except for any Work identified as "Specialty Work" in the Contract Documents. The total bid amount for any such Specialty Work, as shown on the Bid Schedule, may be deducted from the base bid price before computing the <___>% self-performance requirement. The remaining Work may be performed by qualified Subcontractor(s).
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The following provision should be used if additive or deductive alternates will be used in bidding. The language in this provision should not be altered because it follows the wording of Public Contract Code § 20103.8. It should be copied and pasted into the Instructions to Bidders, numbered, and marked to select the applicable method. The other three methods may be deleted.

- ___ **Additive and Deductive Alternates.** As required by Public Contract Code § 20103.8, if this bid solicitation includes additive or deductive items, the method checked below will be used to determine the lowest bid. If no method is checked, subparagraph (A) will be used to determine the lowest bid. City retains the right to add to or deduct from the Contract any of the additive or deductive alternates included in the Bid Proposal.

_____ (A) The lowest bid will be the lowest bid price on the base contract without consideration of the prices on the additive or deductive items.

_____ (B) The lowest bid will be the lowest total of the bid prices on the base contract and those additive or deductive items that were specifically identified in the bid solicitation or Bid Proposal as being used for the purpose of determining the lowest bid price.

_____ (C) The lowest bid will be the lowest total of the bid prices on the base contract and those additive or deductive items taken in order from a specifically identified list of those items that, when in the solicitation, and added to, or subtracted from, the base contract, are less than, or equal to, a funding amount publicly disclosed by City before the first bid is opened.

_____ (D) The lowest bid will be determined in a manner that prevents any information that would identify any of the bidders or the proposed subcontractors or suppliers from being revealed to City before the ranking of all bidders from lowest to highest has been determined.

The following provision should be completed as indicated and used if bidders are required to submit an itemized Bid Schedule with unit pricing with the Bid Proposal.

- ___ **Bid Schedule.** Each bidder must complete the Bid Schedule form with unit prices as indicated, and submit the completed Bid Schedule with its Bid Proposal.
 - ___**.1 Incorrect Totals.** In the event a computational error for any bid item (base bid or alternate) results in an incorrect extended total for that item, the submitted base bid or bid alternate total will be adjusted to reflect the corrected amount as the product of the estimated quantity and the unit cost. In the event of a discrepancy between the actual total of the itemized or unit prices shown on the Bid Schedule for the base bid, and the amount entered as the base bid on the Bid Proposal form, the actual total of the itemized or unit prices shown on the Bid Schedule for the base bid will be deemed the base bid price. Likewise, in the event of a discrepancy between the actual total of the itemized or unit prices shown on the Bid Schedule for any bid alternate, and the amount entered for the alternate on the Bid Proposal form, the actual total of the itemized prices shown on the Bid Schedule for that alternate will be deemed the alternate price. Nothing in this provision is intended to prevent a bidder from requesting to withdraw its bid for material error under Public Contract Code § 5100 et seq.
 - ___**.2 Estimated Quantities.** Unless identified as a “Final Pay Quantity,” the quantities shown on the Bid Schedule are estimated and the actual quantities required to perform the Work may be greater or less than the estimated amount. The Contract Price will be adjusted to reflect the actual quantities required for the Work based on the itemized or unit prices provided in the Bid Schedule, with no allowance for anticipated profit for quantities that are deleted or decreased, and no increase in the unit price, and without regard to the percentage increase or decrease of the estimated quantity and the actual quantity.
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The following provision should be used if the City wishes to require bidders to submit a completed Bidder’s Questionnaire. The optional Bidder’s Questionnaire form should not be required for projects which already require prequalification if it would duplicate information required in the prequalification process.

- ___ **Bidder’s Questionnaire.** A completed, signed Bidder’s Questionnaire using the form provided with the Contract Documents and including all required attachments must be submitted within 48 hours following a request by City. A bid that does not fully comply with this requirement may be rejected as nonresponsive. A bidder who submits a Bidder’s Questionnaire which is subsequently determined to contain false or misleading information, or material omissions, may be disqualified as non-responsible.
-

Add the following provision to list all documents provided as “For Reference Only” pursuant to Section 3.4 of the General Conditions, including all documents made available by the City or appended to the project manual for information only, and not as Contract Documents, such as geotechnical reports, record drawings or as-builts, or other information about the project or project site.

- ___ **For Reference Only.** The following documents are provided “For Reference Only,” as defined in Section 3.4 of the General Conditions:
_____ <list documents with precise title and date>
-
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Add the following provision if the contract is to be funded, in whole or in part, by federal funding aid subject to the requirements of 2 CFR §§ 200.317 – 200.327, which may include disaster-related emergency work that is potentially eligible for FEMA reimbursement.

- ___ **Federal Subcontracting Requirements.** This Project is funded in whole or in part by the federal government. Contractor must comply with all applicable federal requirements as further specified in the Contract Documents, and when procuring Subcontractors, must take all necessary affirmative steps pursuant to 2 CFR § 200.321(b), subject to the limitations of law, to ensure that minority businesses, women’s business enterprises, and labor surplus area firms are used when possible. Affirmative steps must include:
- ___**.1 Solicitation Lists.** Placing qualified small and minority businesses and women’s business enterprises on solicitation lists.
 - ___**.2 Soliciting Potential Sources.** Assuring that small and minority businesses and women’s business enterprises are solicited whenever they are potential sources.
 - ___**.3 Maximizing Participation.** Dividing total requirements, when economically feasible, into smaller tasks or quantities to permit maximum participation by small and minority businesses and women’s business enterprises.
 - ___**.4 Establishing Delivery Schedules.** Establishing delivery schedules, where the requirement permits, which encourage participation by small and minority businesses, and women’s business enterprises.
 - ___**.5 Organizational Assistance.** Using the services and assistance, as appropriate, of such organizations as the Small Business Administration and the Minority Business Development Agency of the Department of Commerce.
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Bid Proposal

< _____ > Project

_____ (“Bidder”) hereby submits this Bid Proposal to < _____ > (“City”) for the above-referenced project (“Project”) in response to the Notice Inviting Bids and in accordance with the Contract Documents referenced in the Notice.

1. **Base Bid.** Bidder proposes to perform and fully complete the Work for the Project as specified in the Contract Documents, within the time required for full completion of the Work, including all labor, materials, supplies, and equipment and all other direct or indirect costs including, but not limited to, taxes, insurance and all overhead for the following price (“Base Bid”):
\$ _____.

2. **Addenda.** Bidder agrees that it has confirmed receipt of or access to, and reviewed, all addenda issued for this bid. Bidder waives any claims it might have against the City based on its failure to receive, access, or review any addenda for any reason. Bidder specifically acknowledges receipt of the following addenda:

Addendum:	Date Received:	Addendum:	Date Received:
#01	_____	#05	_____
#02	_____	#06	_____
#03	_____	#07	_____
#04	_____	#08	_____

3. **Bidder’s Certifications and Warranties.** By signing and submitting this Bid Proposal, Bidder certifies and warrants the following:

3.1 **Examination of Contract Documents.** Bidder has thoroughly examined the Contract Documents and represents that, to the best of Bidder’s knowledge, there are no errors, omissions, or discrepancies in the Contract Documents, subject to the limitations of Public Contract Code § 1104.

3.2 **Examination of Worksite.** Bidder has had the opportunity to examine the Worksite and local conditions at the Project location.

3.3 **Bidder Responsibility.** Bidder is a responsible bidder, with the necessary ability, capacity, experience, skill, qualifications, workforce, equipment, and resources to perform or cause the Work to be performed in accordance with the Contract Documents and within the Contract Time.

3.4 **Responsibility for Bid.** Bidder has carefully reviewed this Bid Proposal and is solely responsible for any errors or omissions contained in its completed bid. All statements and information provided in this Bid Proposal and enclosures are true and correct to the best of Bidder’s knowledge.

3.5 **Nondiscrimination.** In preparing this bid, the Bidder has not engaged in discrimination against any prospective or present employee or Subcontractor on grounds of race, color, ancestry, national origin, ethnicity, religion, sex, sexual orientation, age, disability, or marital status.

3.6 **Iran Contracting Act.** If the Contract Price exceeds \$1,000,000, Bidder is not identified on a list created under the Iran Contracting Act, Public Contract Code § 2200 et seq. (the “Act”),

as a person engaging in investment activities in Iran, as defined in the Act, or is otherwise expressly exempt under the Act.

4. **Award of Contract.** By signing and submitting this Bid Proposal, Bidder agrees that if Bidder is awarded the Contract for the Project, within ten days following issuance of the Notice of Potential Award to Bidder, Bidder will do all of the following:
- 4.1 **Execute Contract.** Enter into the Contract with City in accordance with the terms of this Bid Proposal, by signing and submitting to City the Contract prepared by City using the form included with the Contract Documents;
- 4.2 **Submit Required Bonds.** Submit to City a payment bond and a performance bond, each for 100% of the Contract Price, using the bond forms provided and in accordance with the requirements of the Contract Documents; and
- 4.3 **Insurance Requirements.** Submit to City the insurance certificate(s) and endorsement(s) as required by the Contract Documents.
5. **Bid Security.** As a guarantee that, if awarded the Contract, Bidder will perform its obligations under Section 4 above, Bidder is enclosing bid security in the amount of ten percent of its maximum bid amount in one of the following forms (check one):

_____ A cashier's check or certified check payable to City and issued by
_____ [Bank name] in the amount of
\$_____.

_____ A bid bond, using the Bid Bond form included with the Contract Documents, payable to City and executed by a surety licensed to do business in the State of California.

This Bid Proposal is hereby submitted on _____, 20__.

s/ _____

Name and Title

s/ _____
[See Section 3 of Instructions to Bidders]

Name and Title

Company Name

License #, Expiration Date, and Classification

Address

DIR Registration #

City, State, Zip

Phone

Contact Name

Contact Email

END OF BID PROPOSAL

Optional Provision for Bid Proposal form:

*The following provision should be added to the Bid Proposal form only if bid alternates are being used. It should be completed as indicated to identify the applicable alternate(s), and to indicate whether the amount(s) to be quoted should be added to or deducted from the Base Bid. It should be inserted after Section 1, Base Bid, and the following Sections renumbered accordingly. If bid alternates are being used, be sure to use the optional provision in the Instructions to Bidders, indicating the method to be used to determine the low bid. **Delete instructions and notes (in italics) and unused optional provisions.***

2. Bid Alternates. Bidder submits the following prices for the specified bid alternates:

Alternate #1: _____ <title/description>
Add/Deduct: \$ _____

Alternate #2: _____ <title/description>
Add/Deduct: \$ _____

Alternate #3: _____ <title/description>
Add/Deduct: \$ _____

Bid Schedule

This Bid Schedule must be completed in ink and included with the sealed Bid Proposal. Pricing must be provided for each Bid Item as indicated. Items marked "(SW)" are Specialty Work that must be performed by a qualified Subcontractor. The lump sum or unit cost for each item must be inclusive of all costs, whether direct or indirect, including profit and overhead. The sum of all amounts entered in the "Extended Total Amount" column must be identical to the Base Bid price entered in Section 1 of the Bid Proposal form.

AL = Allowance CF = Cubic Feet CY = Cubic Yard EA = Each LB = Pounds
 LF = Linear Foot LS = Lump Sum SF = Square Feet TON = Ton (2000 lbs)

BID ITEM NO.	ITEM DESCRIPTION	EST. QTY.	UNIT	UNIT COST	EXTENDED TOTAL AMOUNT
1				\$	\$
2				\$	\$
3				\$	\$
4				\$	\$
5				\$	\$
6				\$	\$
7				\$	\$
8				\$	\$
9				\$	\$
10				\$	\$
11				\$	\$
12				\$	\$
13				\$	\$
14				\$	\$
15				\$	\$
16				\$	\$
17				\$	\$
18				\$	\$
19				\$	\$
20				\$	\$
21				\$	\$
22				\$	\$
23				\$	\$
24				\$	\$
25				\$	\$

BID ITEM NO.	ITEM DESCRIPTION	EST. QTY.	UNIT	UNIT COST	EXTENDED TOTAL AMOUNT
26				\$	\$
27				\$	\$
28				\$	\$
29				\$	\$
30				\$	\$
31				\$	\$
32				\$	\$
33				\$	\$
34				\$	\$
35				\$	\$
36				\$	\$
37				\$	\$
38				\$	\$
39				\$	\$
40				\$	\$
41				\$	\$
42				\$	\$
43				\$	\$
44				\$	\$
45				\$	\$
46				\$	\$
47				\$	\$
48				\$	\$
49				\$	\$
50				\$	\$

* Final Pay Quantity

TOTAL BASE BID: Items 1 through _____ inclusive: \$ _____

Note: The amount entered as the "Total Base Bid" should be identical to the Base Bid amount entered in Section 1 of the Bid Proposal form.

BIDDER NAME: _____

END OF BID SCHEDULE

Subcontractor List

For each Subcontractor that will perform a portion of the Work in an amount in excess of one-half of 1% of the Bidder's total Base Bid,¹ the bidder must list a description of the Work, the name of the Subcontractor, its California contractor license number, the location of its place of business, its DIR registration number, and the portion of the Work that the Subcontractor is performing based on a percentage of the Base Bid price.

DESCRIPTION OF WORK	SUBCONTRACTOR NAME	CALIFORNIA CONTRACTOR LICENSE NO.	LOCATION OF BUSINESS	DIR REG. NO.	PERCENT OF WORK

END OF SUBCONTRACTOR LIST

¹ For street or highway construction, this requirement applies to any subcontract of \$10,000 or more.

Noncollusion Declaration

TO BE EXECUTED BY BIDDER AND SUBMITTED WITH BID

The undersigned declares:

I am the _____ [title] of _____
[business name], the party making the foregoing bid.

The bid is not made in the interest of, or on behalf of, any undisclosed person, partnership, company, association, organization, or corporation. The bid is genuine and not collusive or sham. The bidder has not directly or indirectly induced or solicited any other bidder to put in a false or sham bid. The bidder has not directly or indirectly colluded, conspired, connived, or agreed with any bidder or anyone else to put in a sham bid, or to refrain from bidding. The bidder has not in any manner, directly or indirectly, sought by agreement, communication, or conference with anyone to fix the bid price of the bidder or any other bidder, or to fix any overhead, profit, or cost element of the bid price, or of that of any other bidder. All statements contained in the bid are true. The bidder has not, directly or indirectly, submitted his or her bid price or any breakdown thereof, or the contents thereof, or divulged information or data relative thereto, to any corporation, partnership, company, association, organization, bid depository, or to any member or agent thereof, to effectuate a collusive or sham bid, and has not paid and will not pay, any person or entity for such purpose.

This declaration is intended to comply with California Public Contract Code § 7106 and Title 23 U.S.C § 112.

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct and that this declaration is executed on _____ [date], at _____ [city], _____ [state].

s/ _____

Name [print]

END OF NONCOLLUSION DECLARATION

Bid Bond

_____ (“Bidder”) has submitted a bid, dated _____, 20____ (“Bid”), to < _____ > (“City”) for work on the < _____ > Project (“Project”). Under this duly executed bid bond (“Bid Bond”), Bidder as Principal and _____, its surety (“Surety”), are bound to City as obligee in the penal sum of ten percent of the maximum amount of the Bid (the “Bond Sum”). Bidder and Surety bind themselves and their respective heirs, executors, administrators, successors and assigns, jointly and severally, as follows:

1. **General.** If Bidder is awarded the Contract for the Project, Bidder will enter into the Contract with City in accordance with the terms of the Bid.
2. **Submittals.** Within ten days following issuance of the Notice of Potential Award to Bidder, Bidder must submit to City the following:
 - 2.1 **Contract.** The executed Contract, using the form provided by City in the Project contract documents (“Contract Documents”);
 - 2.2 **Payment Bond.** A payment bond for 100% of the maximum Contract Price, executed by a surety licensed to do business in the State of California using the Payment Bond form included with the Contract Documents;
 - 2.3 **Performance Bond.** A performance bond for 100% of the maximum Contract Price, executed by a surety licensed to do business in the State of California using the Performance Bond form included with the Contract Documents; and
 - 2.4 **Insurance.** The insurance certificate(s) and endorsement(s) required by the Contract Documents, and any other documents required by the Instructions to Bidders or Notice of Potential Award.
3. **Enforcement.** If Bidder fails to execute the Contract and to submit the bonds and insurance certificates as required by the Contract Documents, Surety guarantees that Bidder forfeits the Bond Sum to City. Any notice to Surety may be given in the manner specified in the Contract and delivered or transmitted to Surety as follows:

Attn: _____
Address: _____
City/State/Zip: _____
Phone: _____
Fax: _____
Email: _____

4. **Duration and Waiver.** If Bidder fulfills its obligations under Section 2, above, then this obligation will be null and void; otherwise, it will remain in full force and effect for 60 days following the bid opening or until this Bid Bond is returned to Bidder, whichever occurs first. Surety waives the provisions of Civil Code §§ 2819 and 2845.

[Signatures are on the following page.]

This Bid Bond is entered into and effective on _____, 20_____.

SURETY:

Business Name

s/ _____

Date

Name, Title

(Attach Acknowledgment with Notary Seal and Power of Attorney)

BIDDER:

Business Name

s/ _____

Date

Name, Title

END OF BID BOND

Bidder's Questionnaire

< _____ > **PROJECT**

Within 48 hours following a request by City, a bidder must submit to City a completed, signed Bidder's Questionnaire using this form and all required attachments, including clearly labeled additional sheets as needed. City may request the Questionnaire from one or more of the apparent low bidders following the bid opening, and may use the completed Questionnaire as part of its investigation to evaluate a bidder's qualifications for this Project. The Questionnaire must be filled out completely, accurately, and legibly. Any errors, omissions, or misrepresentations in completion of the Questionnaire may be grounds for rejection of the bid or termination of a Contract awarded pursuant to the bid.

Part A: General Information

Bidder Business Name: _____ ("Bidder")

Check One: ___ Corporation (State of incorporation: _____)
 ___ Partnership
 ___ Sole Proprietorship
 ___ Joint Venture of: _____
 ___ Other: _____

Main Office Address and Phone: _____

Local Office Address and Phone: _____

Website address: _____

Owner of Business: _____

Contact Name and Title: _____

Contact Phone and Email: _____

Bidder's California Contractor's License Number(s): _____

Bidder's DIR Registration Number: _____

Part B: Bidder Experience

- 1. How many years has Bidder been in business under its present business name? ____ years
- 2. Has Bidder completed projects similar in type and size to this Project as a general contractor?
____ Yes ____ No
- 3. Has Bidder ever been disqualified from a bid on grounds that it is not responsible, or otherwise disqualified or disbarred from bidding under state or federal law?
____ Yes ____ No

If yes, provide additional information on a separate sheet regarding the disqualification or disbarment, including the name and address of the agency or owner of the project, the type and size of the project, the reasons that Bidder was disqualified or disbarred, and the month and year in which the disqualification or disbarment occurred.

4. Has Bidder ever been terminated for cause, alleged default, or legal violation from a construction project, either as a general contractor or as a subcontractor?

_____ Yes _____ No

If yes, provide additional information on a separate sheet regarding the termination, including the name and address of the agency or owner of the subject project, the type and size of the project, whether Bidder was under contract as a general contractor or a subcontractor, the reasons that Bidder was terminated, and the month and year in which the termination occurred.

5. Provide information about Bidder's past projects performed as general contractor as follows:

- 5.1 Six most recently completed public works projects within the last three years;
- 5.2 Three largest completed projects within the last three years; and
- 5.3 Any project which is similar to this Project including scope and character of the work.

6. Use separate sheets to provide all of the following information for each project identified in response to the above three categories:

- 6.1 Project name, location, and description;
- 6.2 Owner (name, address, email, and phone number);
- 6.3 Prime contractor, if applicable (name, address, email, and phone number);
- 6.4 Architect or engineer (name, email, and phone number);
- 6.5 Project and/or construction manager (name, email, and phone number);
- 6.6 Scope of work performed (as general or as subcontractor);
- 6.7 Initial contract price and final contract price (including change orders);
- 6.8 Original scheduled completion date and actual date of completion;
- 6.9 Time extensions granted (number of days);
- 6.10 Number and amount of stop notices or mechanic's liens filed;
- 6.11 Amount of any liquidated damages assessed against Bidder; and
- 6.12 Nature and resolution of any project-related claim, lawsuit, mediation, or arbitration involving Bidder.

Part C: Safety

1. Provide Bidder's Experience Modification Rate (EMR) for the last three years:

Year	EMR

2. Complete the following, based on information provided in Bidder's CalOSHA Form 300 or Form 300A, Annual Summary of Work-Related Illnesses and Injuries, from the most recent past calendar year:

- 2.1 Number of lost workday cases: _____
- 2.2 Number of medical treatment cases: _____
- 2.3 Number of deaths: _____

3. Has Bidder ever been cited, fined, or prosecuted by any local, state, or federal agency, including OSHA, CalOSHA, or EPA, for violation of any law, regulation, or requirements pertaining to health and safety?

_____ Yes _____ No

If yes, provide additional information on a separate sheet regarding each such citation, fine, or prosecution, including the name and address of the agency or owner of the project, the type and size of the project, the reasons for and nature of the citation, fine, or prosecution, and the month and year in which the incident giving rise to the citation, fine, or prosecution occurred.

4. Name, title, and email for person responsible for Bidder's safety program:

Name	Title	Email

Part D: Verification

In signing this document, I, the undersigned, declare that I am duly authorized to sign and submit this Bidder's Questionnaire on behalf of the named Bidder, and that all responses and information set forth in this Bidder's Questionnaire and accompanying attachments are, to the best of my knowledge, true, accurate and complete as of the date of submission. **I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct.**

Signature: _____ Date: _____

By: _____
Name and Title

END OF BIDDER'S QUESTIONNAIRE

Contract

This public works contract ("Contract") is entered into by and between <_____> ("City") and _____ ("Contractor"), for work on the <_____> Project ("Project").

The parties agree as follows:

1. **Award of Contract.** In response to the Notice Inviting Bids, Contractor has submitted a Bid Proposal to perform the Work to construct the Project. On _____, 20____, City authorized award of this Contract to Contractor for the amount set forth in Section 4, below.
2. **Contract Documents.** The Contract Documents incorporated into this Contract include and are comprised of all of the documents listed below. The definitions provided in Article 1 of the General Conditions apply to all of the Contract Documents, including this Contract.

- 2.1 Notice Inviting Bids;
- 2.2 Instructions to Bidders;
- 2.3 Addenda, if any;
- 2.4 Bid Proposal and attachments thereto;
- 2.5 Contract;
- 2.6 Payment and Performance Bonds;
- 2.7 General Conditions;
- 2.8 Special Conditions;
- 2.9 Project Plans and Specifications;
- 2.10 Change Orders, if any;
- 2.11 Notice of Potential Award;
- 2.12 Notice to Proceed; and
- 2.13 The following:

_____. <List additional documents here, if any, including the formal title and document date. If there are no additional documents, write "No other documents" in the space above.>

3. **Contractor's Obligations.** Contractor will perform all of the Work required for the Project, as specified in the Contract Documents. Contractor must provide, furnish, and supply all things necessary and incidental for the timely performance and completion of the Work, including all necessary labor, materials, supplies, tools, equipment, transportation, onsite facilities, and utilities, unless otherwise specified in the Contract Documents. Contractor must use its best efforts to diligently prosecute and complete the Work in a professional and expeditious manner and to meet or exceed the performance standards required by the Contract Documents.
4. **Payment.** As full and complete compensation for Contractor's timely performance and completion of the Work in strict accordance with the terms and conditions of the Contract Documents, City will pay Contractor \$_____ ("Contract Price") for all of Contractor's direct and indirect costs to perform the Work, including all labor, materials, supplies, equipment, taxes, insurance, bonds and all overhead costs, in accordance with the payment provisions in the General Conditions.
5. **Time for Completion.** Contractor will fully complete the Work for the Project, meeting all requirements for Final Completion, within <_____> calendar days from the commencement date given in the Notice to Proceed ("Contract Time"). By signing below, Contractor expressly waives any claim for delayed early completion.

6. **Liquidated Damages.** As further specified in Section 5.4 of the General Conditions, if Contractor fails to complete the Work within the Contract Time, City will assess liquidated damages in the amount of \$<_____> per day for each day of unexcused delay in achieving Final Completion, and such liquidated damages may be deducted from City's payments due or to become due to Contractor under this Contract.
7. **Labor Code Compliance.**
- 7.1 **General.** This Contract is subject to all applicable requirements of Chapter 1 of Part 7 of Division 2 of the Labor Code, including requirements pertaining to wages, working hours and workers' compensation insurance, as further specified in Article 9 of the General Conditions.
- 7.2 **Prevailing Wages.** This Project is subject to the prevailing wage requirements applicable to the locality in which the Work is to be performed for each craft, classification or type of worker needed to perform the Work, including employer payments for health and welfare, pension, vacation, apprenticeship and similar purposes. Copies of these prevailing rates are available online at <http://www.dir.ca.gov/DLSR>.
- 7.3 **DIR Registration.** City may not enter into the Contract with a bidder without proof that the bidder and its Subcontractors are registered with the California Department of Industrial Relations to perform public work pursuant to Labor Code § 1725.5, subject to limited legal exceptions.
8. **Workers' Compensation Certification.** Pursuant to Labor Code § 1861, by signing this Contract, Contractor certifies as follows: "I am aware of the provisions of Labor Code § 3700 which require every employer to be insured against liability for workers' compensation or to undertake self-insurance in accordance with the provisions of that code, and I will comply with such provisions before commencing the performance of the Work on this Contract."
9. **Conflicts of Interest.** Contractor, its employees, Subcontractors and agents, may not have, maintain or acquire a conflict of interest in relation to this Contract in violation of any City ordinance or requirement, or in violation of any California law, including Government Code § 1090 et seq., or the Political Reform Act, as set forth in Government Code § 81000 et seq. and its accompanying regulations. Any violation of this Section constitutes a material breach of the Contract.
10. **Independent Contractor.** Contractor is an independent contractor under this Contract and will have control of the Work and the means and methods by which it is performed. Contractor and its Subcontractors are not employees of City and are not entitled to participate in any health, retirement, or any other employee benefits from City.
11. **Notice.** Any notice, billing, or payment required by or pursuant to the Contract Documents must be made in writing, signed, dated and sent to the other party by personal delivery, U.S. Mail, a reliable overnight delivery service, or by email as a PDF file. Notice is deemed effective upon delivery, except that service by U.S. Mail is deemed effective on the second working day after deposit for delivery. Notice for each party must be given as follows:

City:

<Department or Title>
<Address>
<City/State/Zip>

<Phone (optional)>
Attn: <Name/Title>
<Email address>

Copy to: <Name/Title>
<Email address>

Contractor:

Name: _____
Address: _____
City/State/Zip: _____
Phone: _____
Attn: _____
Email: _____
Copy to: _____

12. General Provisions.

12.1 Assignment and Successors. Contractor may not assign its rights or obligations under this Contract, in part or in whole, without City’s written consent. This Contract is binding on Contractor’s and City’s lawful heirs, successors and permitted assigns.

12.2 Third Party Beneficiaries. There are no intended third party beneficiaries to this Contract.

12.3 Governing Law and Venue. This Contract will be governed by California law and venue will be in the <_____> County Superior Court, and no other place. Contractor waives any right it may have pursuant to Code of Civil Procedure § 394, to file a motion to transfer any action arising from or relating to this Contract to a venue outside of <_____> County, California.

12.4 Amendment. No amendment or modification of this Contract will be binding unless it is in a writing duly authorized and signed by the parties to this Contract.

12.5 Integration. This Contract and the Contract Documents incorporated herein, including authorized amendments or Change Orders thereto, constitute the final, complete, and exclusive terms of the agreement between City and Contractor.

12.6 Severability. If any provision of the Contract Documents is determined to be illegal, invalid, or unenforceable, in whole or in part, the remaining provisions of the Contract Documents will remain in full force and effect.

12.7 Iran Contracting Act. If the Contract Price exceeds \$1,000,000, Contractor certifies, by signing below, that it is not identified on a list created under the Iran Contracting Act, Public Contract Code § 2200 et seq. (the “Act”), as a person engaging in investment activities in Iran, as defined in the Act, or is otherwise expressly exempt under the Act.

12.8 Authorization. Each individual signing below warrants that he or she is authorized to do so by the party that he or she represents, and that this Contract is legally binding on that party. If Contractor is a corporation, signatures from two officers of the corporation are required pursuant to California Corporation Code § 313.

The parties agree to this Contract as witnessed by the signatures below:

CITY:

Approved as to form:

s/ _____

s/ _____

Name, Title

Name, Title

Date: _____

Date: _____

Attest:

s/ _____

Name, Title

Date: _____

CONTRACTOR: _____
Business Name

s/ _____

Seal:

Name, Title

Date: _____

Second Signature (See Section 12.8):

s/ _____

Name, Title

Date: _____

Contractor's California License Number(s) and Expiration Date(s)

END OF CONTRACT

Payment Bond

< _____ > ("City") and _____
("Contractor") have entered into a contract for work on the
< _____ > Project ("Project"). The Contract
is incorporated by reference into this Payment Bond ("Bond").

- 1. General.** Under this Bond, Contractor as principal and _____, its surety ("Surety"), are bound to City as obligee in an amount not less than \$ _____, under California Civil Code § 9550 et seq., to ensure payment to authorized claimants. This Bond is binding on the respective successors, assigns, owners, heirs, or executors of Surety and Contractor.
- 2. Surety's Obligation.** If Contractor or any of its Subcontractors fails to pay a person authorized in California Civil Code § 9100 to assert a claim against a payment bond, any amounts due under the Unemployment Insurance Code with respect to work or labor performed under the Contract, or any amounts required to be deducted, withheld, and paid over to the Employment Development Department from the wages of employees of Contractor and its Subcontractors under California Unemployment Insurance Code § 13020 with respect to the work and labor, then Surety will pay the obligation.
- 3. Beneficiaries.** This Bond inures to the benefit of any of the persons named in California Civil Code § 9100, so as to give a right of action to those persons or their assigns in any suit brought upon this Bond. Contractor must promptly provide a copy of this Bond upon request by any person with legal rights under this Bond.
- 4. Duration.** If Contractor promptly makes payment of all sums for all labor, materials, and equipment furnished for use in the performance of the Work required by the Contract, in conformance with the time requirements set forth in the Contract and as required by California law, Surety's obligations under this Bond will be null and void. Otherwise, Surety's obligations will remain in full force and effect.
- 5. Waivers.** Surety waives any requirement to be notified of alterations to the Contract or extensions of time for performance of the Work under the Contract. Surety waives the provisions of Civil Code §§ 2819 and 2845. City waives the requirement of a new bond for any supplemental contract under Civil Code § 9550. Any notice to Surety may be given in the manner specified in the Contract and delivered or transmitted to Surety as follows:

Attn: _____
Address: _____
City/State/Zip: _____
Phone: _____
Email: _____
- 6. Law and Venue.** This Bond will be governed by California law, and venue for any dispute pursuant to this Bond will be in the < _____ > County Superior Court, and no other place. Surety will be responsible for City's attorneys' fees and costs in any action to enforce the provisions of this Bond.

[Signatures are on the following page.]

7. **Effective Date; Execution.** This Bond is entered into and is effective on _____,
20__.

SURETY:

Business Name

s/ _____

Date

Name, Title

(Attach Acknowledgment with Notary Seal and Power of Attorney)

CONTRACTOR:

Business Name

s/ _____

Date

Name, Title

APPROVED BY CITY:

s/ _____

Date

Name, Title

END OF PAYMENT BOND

Performance Bond

< _____ > ("City") and _____
("Contractor") have entered into a contract for work on the
< _____ > Project ("Project"). The Contract is
incorporated by reference into this Performance Bond ("Bond").

1. **General.** Under this Bond, Contractor as principal and _____, its surety ("Surety"), are bound to City as obligee for an amount not less than \$ _____ to ensure Contractor's faithful performance of its obligations under the Contract. This Bond is binding on the respective successors, assigns, owners, heirs, or executors of Surety and Contractor.
2. **Surety's Obligations.** Surety's obligations are co-extensive with Contractor's obligations under the Contract. If Contractor fully performs its obligations under the Contract, including its warranty obligations under the Contract, Surety's obligations under this Bond will become null and void. Otherwise, Surety's obligations will remain in full force and effect.
3. **Waiver.** Surety waives any requirement to be notified of and further consents to any alterations to the Contract made under the applicable provisions of the Contract Documents, including changes to the scope of Work or extensions of time for performance of Work under the Contract. Surety waives the provisions of Civil Code §§ 2819 and 2845.
4. **Application of Contract Balance.** Upon making a demand on this Bond for completion of the Work prior to acceptance of the Project, City will make the Contract Balance available to Surety for completion of the Work under the Contract. For purposes of this provision, the Contract Balance is defined as the total amount payable by City to Contractor as the Contract Price minus amounts already paid to Contractor, and minus any liquidated damages, credits, or backcharges to which City is entitled under the terms of the Contract.
5. **Contractor Default.** Upon written notification from City of Contractor's termination for default under Article 13 of the Contract General Conditions, time being of the essence, Surety must act within the time specified in Article 13 to remedy the default through one of the following courses of action:
 - 5.1 Arrange for completion of the Work under the Contract by Contractor, with City's consent, but only if Contractor is in default solely due to its financial inability to complete the Work;
 - 5.2 Arrange for completion of the Work under the Contract by a qualified contractor acceptable to City, and secured by performance and payment bonds issued by an admitted surety as required by the Contract Documents, at Surety's expense; or
 - 5.3 Waive its right to complete the Work under the Contract and reimburse City the amount of City's costs to have the remaining Work completed.
6. **Surety Default.** If Surety defaults on its obligations under the Bond, City will be entitled to recover all costs it incurs due to Surety's default, including legal, design professional, or delay costs.
7. **Notice.** Any notice to Surety may be given in the manner specified in the Contract and sent to Surety as follows:

Attn: _____

Address: _____
City/State/Zip: _____
Phone: _____
Fax: _____
Email: _____

8. **Law and Venue.** This Bond will be governed by California law, and venue for any dispute pursuant to this Bond will be in the <_____> County Superior Court, and no other place. Surety will be responsible for City's attorneys' fees and costs in any action to enforce the provisions of this Bond.
9. **Effective Date; Execution.** This Bond is entered into and effective on _____, 20____.

SURETY:

Business Name

s/ _____

Date

Name, Title

(Attach Acknowledgment with Notary Seal and Power of Attorney)

CONTRACTOR:

Business Name

s/ _____

Date

Name, Title

APPROVED BY CITY:

s/ _____

Date

Name, Title

END OF PERFORMANCE BOND

General Conditions

Article 1 - Definitions

Definitions. The following definitions apply to all of the Contract Documents unless otherwise indicated, e.g., additional definitions that apply solely to the Specifications or other technical documents. Defined terms and titles of documents are capitalized in the Contract Documents, with the exception of the following (in any tense or form): “day,” “furnish,” “including,” “install,” “work day” or “working day.”

Allowance means a specific amount that must be included in the Bid Proposal for a specified purpose.

Article, as used in these General Conditions, means a numbered Article of the General Conditions, unless otherwise indicated by the context.

Change Order means a written document duly approved and executed by City, which changes the scope of Work, the Contract Price, or the Contract Time.

City means the municipality which has entered into the Contract with Contractor for performance of the Work, acting through its City Council, officers, employees, City Engineer, and any other authorized representatives.

City Engineer means the City Engineer for City and his or her authorized delegee(s).

Claim means a separate demand by Contractor for a change in the Contract Time or Contract Price, that has previously been submitted to City in accordance with the requirements of the Contract Documents, and which has been rejected by City, in whole or in part; or a written demand by Contractor objecting to the amount of Final Payment.

Contract means the signed agreement between City and Contractor for performing the Work required for the Project, and all documents expressly incorporated therein.

Contract Documents means, collectively, all of the documents listed as such in Section 2 of the Contract, including the Notice Inviting Bids; the Instructions to Bidders; addenda, if any; the Bid Proposal, and attachments thereto; the Contract; the Notice of Potential Award and Notice to Proceed; the payment and performance bonds; the General Conditions; the Special Conditions; the Project Plans and Specifications; any Change Orders; and any other documents which are clearly and unambiguously made part of the Contract Documents. The Contract Documents do not include documents provided “For Reference Only,” or documents that are intended solely to provide information regarding existing conditions.

Contract Price means the total compensation to be paid to Contractor for performance of the Work, as set forth in the Contract and as may be amended by Change Order or adjusted for an Allowance. The Contract Price is not subject to adjustment due to inflation or due to the increased cost of labor, material, supplies or equipment following submission of the Bid Proposal.

Contract Time means the time specified for complete performance of the Work, as set forth in the Contract and as may be amended by Change Order.

Contractor means the individual, partnership, corporation, or joint-venture that has signed the Contract with City to perform the Work.

Day means a calendar day unless otherwise specified.

Design Professional means the licensed individual(s) or firm(s) retained by City to provide architectural, engineering, or electrical engineering design services for the Project. If no Design Professional has been retained for this Project, any reference to Design Professional is deemed to refer to the Engineer.

DIR means the California Department of Industrial Relations.

Drawings has the same meaning as Plans.

Engineer means the City Engineer for the City of <_____> and his or her authorized delegates.

Excusable Delay is defined in Section 5.3(B), Excusable Delay.

Extra Work means new or unforeseen work added to the Project, as determined by the Engineer in his or her sole discretion, including Work that was not part of or incidental to the scope of the Work when the Contractor's bid was submitted; Work that is substantially different from the Work as described in the Contract Documents at bid time; or Work that results from a substantially differing and unforeseeable condition.

Final Completion means Contractor has fully completed all of the Work required by the Contract Documents to the City's satisfaction, including all punch list items and any required commissioning or training, and has provided the City with all required submittals, including the instructions and manuals, product warranties, and as-built drawings.

Final Payment means payment to Contractor of the unpaid Contract Price, including release of undisputed retention, less amounts withheld or deducted pursuant to the Contract Documents.

Furnish means to purchase and deliver for the Project.

Government Code Claim means a claim submitted pursuant to California Government Code § 900 et seq.

Hazardous Materials means any substance or material identified now or in the future as hazardous under any Laws, or any other substance or material that may be considered hazardous or otherwise subject to Laws governing handling, disposal, or cleanup.

Including, whether or not capitalized, means "including, but not limited to," unless the context clearly requires otherwise.

Inspector means the individual(s) or firm(s) retained or employed by City to inspect the workmanship, materials, and manner of construction of the Project and its components to ensure compliance with the Contract Documents and all Laws.

Install means to fix in place for materials, and to fix in place and connect for equipment.

Laws means all applicable local, state, and federal laws, regulations, rules, codes, ordinances, permits, orders, and the like enacted or imposed by or under the auspices of any governmental entity with jurisdiction over any of the Work or any performance of the Work, including health and safety requirements.

Non-Excusable Delay is defined in Section 5.3(D), Non-Excusable Delay.

Plans means the City-provided plans, drawings, details, or graphical depictions of the Project requirements, but does not include Shop Drawings.

Project means the public works project referenced in the Contract.

Project Manager means the individual designated by City to oversee and manage the Project on City's behalf and may include his or her authorized delegee(s) when the Project Manager is unavailable. If no Project Manager has been designated for this Project, any reference to Project Manager is deemed to refer to the Engineer.

Recoverable Costs is defined in Section 5.3(F), Recoverable Costs.

Request for Information or **RFI** means Contractor's written request for information about the Contract Documents, the Work or the Project, submitted to City in the manner and format specified by City.

Section, when capitalized in these General Conditions, means a numbered section or subsection of the General Conditions, unless the context clearly indicates otherwise.

Shop Drawings means drawings, plan details or other graphical depictions prepared by or on behalf of Contractor, and subject to City acceptance, which are intended to provide details for fabrication, installation, and the like, of items required by or shown in the Plans or Specifications.

Specialty Work means Work that must be performed by a specialized Subcontractor with the specified license or other special certification, and that the Contractor is not qualified to self-perform.

Specifications means the technical, text specifications describing the Project requirements, which are prepared for and incorporated into the Contract by or on behalf of City, and does not include the Contract, General Conditions or Special Conditions.

Subcontractor means an individual, partnership, corporation, or joint-venture retained by Contractor directly or indirectly through a subcontract to perform a specific portion of the Work. The term Subcontractor applies to subcontractors of all tiers, unless otherwise indicated by the context. A third party such as a utility performing related work on the Project is not a Subcontractor, even if Contractor must coordinate its Work with the third party.

Technical Specifications has the same meaning as Specifications.

Work means all of the construction and services necessary for or incidental to completing the Project in conformance with the requirements of the Contract Documents.

Work Day or **Working Day**, whether or not capitalized, means a weekday when the City is open for business, and does not include holidays observed by the City.

Worksite means the place or places where the Work is performed, which includes, but may extend beyond the Project site, including separate locations for staging, storage, or fabrication.

Article 2 - Roles and Responsibilities

2.1 City.

(A) **City Council.** The City Council has final authority in all matters affecting the Project, except to the extent it has delegated authority to the Engineer.

(B) **Engineer.** The Engineer, acting within the authority conferred by the City Council, is responsible for administration of the Project on behalf of City, including authority to provide directions to the Design Professional and to Contractor to ensure

proper and timely completion of the Project. The Engineer's decisions are final and conclusive within the scope of his or her authority, including interpretation of the Contract Documents.

(C) **Project Manager.** The Project Manager assigned to the Project will be the primary point of contact for the Contractor and will serve as City's representative for daily administration of the Project on behalf of City. Unless otherwise specified, all of Contractor's communications to City (in any form) will go to or through the Project Manager. City reserves the right to reassign the Project Manager role at any time or to delegate duties to additional City representatives, without prior notice to or consent of Contractor.

(D) **Design Professional.** The Design Professional is responsible for the overall design of the Project and, to the extent authorized by City, may act on City's behalf to ensure performance of the Work in compliance with the Plans and Specifications, including any design changes authorized by Change Order. The Design Professional's duties may include review of Contractor's submittals, visits to any Worksite, inspecting the Work, evaluating test and inspection results, and participation in Project-related meetings, including any pre-construction conference, weekly meetings, and coordination meetings. The Design Professional's interpretation of the Plans or Specifications is final and conclusive.

2.2 Contractor.

(A) **General.** Contractor must provide all labor, materials, supplies, equipment, services, and incidentals necessary to perform and timely complete the Work in strict accordance with the Contract Documents, and in an economical and efficient manner in the best interests of City, and with minimal inconvenience to the public.

(B) **Responsibility for the Work and Risk of Loss.** Contractor is responsible for supervising and directing all aspects of the Work to facilitate the efficient and timely completion of the Work. Contractor is solely responsible for and required to exercise full control over the Work, including the construction means, methods, techniques, sequences, procedures, safety precautions and programs, and coordination of all portions of the Work with that of all other contractors and Subcontractors, except to the extent that the Contract Documents provide other specific instructions. Contractor's responsibilities extend to any plan, method or sequence suggested, but not required by City or specified in the Contract Documents. From the date of commencement of the Work until either the date on which City formally accepts the Project or the effective date of termination of the Contract, whichever is later, Contractor bears all risks of injury or damage to the Work and the materials and equipment delivered to any Worksite, by any cause including fire, earthquake, wind, weather, vandalism or theft.

(C) **Project Administration.** Contractor must provide sufficient and competent administration, staff, and skilled workforce necessary to perform and timely complete the Work in accordance with the Contract Documents. Before starting the Work, Contractor must designate in writing and provide complete contact information, including telephone numbers and email address, for the officer or employee in Contractor's organization who is to serve as Contractor's primary representative for the Project, and who has authority to act on Contractor's behalf. A Subcontractor may not serve as Contractor's primary representative.

(D) **On-Site Superintendent.** Contractor must, at all times during performance of the Work, provide a qualified and competent full-time superintendent acceptable to City, and assistants as necessary, who must be physically present at the Project site while any aspect of the Work is being performed. The superintendent must have full authority to act

and communicate on behalf of Contractor, and Contractor will be bound by the superintendent's communications to City. City's approval of the superintendent is required before the Work commences. If City is not satisfied with the superintendent's performance, City may request a qualified replacement of the superintendent. Failure to comply may result in temporary suspension of the Work, at Contractor's sole expense and with no extension of Contract Time, until an approved superintendent is physically present to supervise the Work. Contractor must provide written notice to City, as soon as practicable, before replacing the superintendent.

(E) **Standards.** Contractor must, at all times, ensure that the Work is performed in an efficient, skillful manner following best practices and in full compliance with the Contract Documents and Laws and applicable manufacturer's recommendations. Contractor has a material and ongoing obligation to provide true and complete information, to the best of its knowledge, with respect to all records, documents, or communications pertaining to the Project, including oral or written reports, statements, certifications, Change Order requests, or Claims.

(F) **Meetings.** Contractor, its project manager, superintendent and any primary Subcontractors requested by City, must attend a pre-construction conference, if requested by City, as well as weekly Project progress meetings scheduled with City. If applicable, Contractor may also be required to participate in coordination meetings with other parties relating to other work being performed on or near the Project site or in relation to the Project, including work or activities performed by City, other contractors, or other utility owners.

(G) **Construction Records.** Contractor will maintain up-to-date, thorough, legible, and dated daily job reports, which document all significant activity on the Project for each day that Work is performed on the Project. The daily report for each day must include the number of workers at the Project site; primary Work activities; major deliveries; problems encountered, including injuries, if any; weather and site conditions; and delays, if any. Contractor will take date and time-stamped photographs to document general progress of the Project, including site conditions prior to construction activities, before and after photographs at offset trench laterals, existing improvements and utilities, damage and restoration. Contractor will maintain copies of all subcontracts, Project-related correspondence with Subcontractors, and records of meetings with Subcontractors. Upon request by the City, Contractor will permit review of and/or provide copies of any of these construction records.

(H) **Responsible Party.** Contractor is solely responsible to City for the acts or omissions of any Subcontractors, or any other party or parties performing portions of the Work or providing equipment, materials or services for or on behalf of Contractor or the Subcontractors. Upon City's written request, Contractor must promptly and permanently remove from the Project, at no cost to City, any employee or Subcontractor or employee of a Subcontractor who the Engineer has determined to be incompetent, intemperate or disorderly, or who has failed or refused to perform the Work as required under the Contract Documents.

(I) **Correction of Defects.** Contractor must promptly correct, at Contractor's sole expense, any Work that is determined by City to be deficient or defective in any way, including workmanship, materials, parts or equipment. Workmanship, materials, parts or equipment that do not conform to the requirements under the Plans, Specifications and every other Contract Document, as determined by City, will be considered defective and subject to rejection. Contractor must also promptly correct, at Contractor's sole expense, any Work performed beyond the lines and grades shown on the Plans or established by City, and any Extra Work performed without City's prior written approval. If Contractor fails to correct or to take reasonable steps toward correcting defective Work within five

days following notice from City, or within the time specified in City's notice to correct, City may elect to have the defective Work corrected by its own forces or by a third party, in which case the cost of correction will be deducted from the Contract Price. If City elects to correct defective Work due to Contractor's failure or refusal to do so, City or its agents will have the right to take possession of and use any equipment, supplies, or materials available at the Project site or any Worksite on City property, in order to effectuate the correction, at no extra cost to City. Contractor's warranty obligations under Section 11.2, Warranty, will not be waived nor limited by City's actions to correct defective Work under these circumstances. Alternatively, City may elect to retain defective Work, and deduct the difference in value, as determined by the Engineer, from payments otherwise due to Contractor. This paragraph applies to any defective Work performed by Contractor during the one-year warranty period under Section 11.2.

(J) **Contractor's Records.** Contractor must maintain all of its records relating to the Project in any form, including paper documents, photos, videos, electronic records, approved samples, and the construction records required pursuant to paragraph (G), above. Project records subject to this provision include complete Project cost records and records relating to preparation of Contractor's bid, including estimates, take-offs, and price quotes or bids.

(1) Contractor's cost records must include all supporting documentation, including original receipts, invoices, and payroll records, evidencing its direct costs to perform the Work, including, but not limited to, costs for labor, materials and equipment. Each cost record should include, at a minimum, a description of the expenditure with references to the applicable requirements of the Contract Documents, the amount actually paid, the date of payment, and whether the expenditure is part of the original Contract Price, related to an executed Change Order, or otherwise categorized by Contractor as Extra Work. Contractor's failure to comply with this provision as to any claimed cost operates as a waiver of any rights to recover the claimed cost.

(2) Contractor must continue to maintain its Project-related records in an organized manner for a period of five years after City's acceptance of the Project or following Contract termination, whichever occurs first. Subject to prior notice to Contractor, City is entitled to inspect or audit any of Contractor's records relating to the Project during Contractor's normal business hours. The record-keeping requirements set forth in this subsection 2.2(J) will survive expiration or termination of the Contract.

(K) **Copies of Project Documents.** Contractor and its Subcontractors must keep copies, at the Project site, of all Work-related documents, including the Contract, permit(s), Plans, Specifications, Addenda, Contract amendments, Change Orders, RFIs and RFI responses, Shop Drawings, as-built drawings, schedules, daily records, testing and inspection reports or results, and any related written interpretations. These documents must be available to City for reference at all times during construction of the Project.

2.3 Subcontractors.

(A) **General.** All Work which is not performed by Contractor with its own forces must be performed by Subcontractors. City reserves the right to approve or reject any and all Subcontractors proposed to perform the Work, for reasons including the subcontractor's poor reputation, lack of relevant experience, financial instability, and lack of technical ability or adequate trained workforce. Each Subcontractor must obtain a City business license before performing any Work.

(B) **Contractual Obligations.** Contractor must require each Subcontractor to comply with the provisions of the Contract Documents as they apply to the Subcontractor's portion(s) of the Work, including the generally applicable terms of the Contract Documents, and to likewise bind their subcontractors. Contractor will provide that the rights that each Subcontractor may have against any manufacturer or supplier for breach of warranty or guarantee relating to items provided by the Subcontractor for the Project, will be assigned to City. Nothing in these Contract Documents creates a contractual relationship between a Subcontractor and City, but City is deemed to be a third-party beneficiary of the contract between Contractor and each Subcontractor.

(C) **Termination.** If the Contract is terminated, each Subcontractor's agreement must be assigned by Contractor to City, subject to the prior rights of any surety, but only if and to the extent that City accepts, in writing, the assignment by written notification, and assumes all rights and obligations of Contractor pursuant to each such subcontract agreement.

(D) **Substitution of Subcontractor.** If Contractor requests substitution of a listed Subcontractor under Public Contract Code § 4107, Contractor is solely responsible for all costs City incurs in responding to the request, including legal fees and costs to conduct a hearing, and any increased subcontract cost to perform the Work that was to be performed by the listed Subcontractor. If City determines that a Subcontractor is unacceptable to City based on the Subcontractor's failure to satisfactorily perform its Work, or for any of the grounds for substitution listed in Public Contract Code § 4107(a), City may request removal of the Subcontractor from the Project. Upon receipt of a written request from City to remove a Subcontractor pursuant to this paragraph, Contractor will immediately remove the Subcontractor from the Project and, at no further cost to City, will either (1) self-perform the remaining Work to the extent that Contractor is duly licensed and qualified to do so, or (2) substitute a Subcontractor that is acceptable to City, in compliance with Public Contract Code § 4107, as applicable.

2.4 Coordination of Work.

(A) **Concurrent Work.** City reserves the right to perform, have performed, or permit performance of other work on or adjacent to the Project site while the Work is being performed for the Project. Contractor is responsible for coordinating its Work with other work being performed on or adjacent to the Project site, including by any utility companies or agencies, and must avoid hindering, delaying, or interfering with the work of other contractors, individuals, or entities, and must ensure safe and reasonable site access and use as required or authorized by City. To the full extent permitted by law, Contractor must hold harmless and indemnify City against any and all claims arising from or related to Contractor's avoidable, negligent, or willful hindrance of, delay to, or interference with the work of any utility company or agency or another contractor or subcontractor.

(B) **Coordination.** If Contractor's Work will connect or interface with work performed by others, Contractor is responsible for independently measuring and visually inspecting such work to ensure a correct connection and interface. Contractor is responsible for any failure by Contractor or its Subcontractors to confirm measurements before proceeding with connecting Work. Before proceeding with any portion of the Work affected by the construction or operations of others, Contractor must give the Project Manager prompt written notification of any defects Contractor discovers which will prevent the proper execution of the Work. Failure to give notice of any known or reasonably discoverable defects will be deemed acknowledgement by Contractor that the work of others is not defective and will not prevent the proper execution of the Work. Contractor must also promptly notify City if work performed by others, including work or activities performed by City's own forces, is operating to hinder, delay, or interfere with Contractor's timely

performance of the Work. City reserves the right to backcharge Contractor for any additional costs incurred due to Contractor's failure to comply with the requirements in this Section 2.4.

2.5 Submittals. Unless otherwise specified, Contractor must submit to the Engineer for review and acceptance, all schedules, Shop Drawings, samples, product data, and similar submittals required by the Contract Documents, or upon request by the Engineer. Unless otherwise specified, all submittals, including Requests for Information, are subject to the general provisions of this Section, as well as specific submittal requirements that may be included elsewhere in the Contract Documents, including the Special Conditions or Specifications. The Engineer may require submission of a submittal schedule at or before a pre-construction conference, as may be specified in the Notice to Proceed.

(A) **General.** Contractor is responsible for ensuring that its submittals are accurate and conform to the Contract Documents.

(B) **Time and Manner of Submission.** Contractor must ensure that its submittals are prepared and delivered in a manner consistent with the current City-accepted schedule for the Work and within the applicable time specified in the Contract Documents, or if no time is specified, in such time and sequence so as not to delay the performance of the Work or completion of the Project.

(C) **Required Contents.** Each submittal must include the Project name and contract number, Contractor's name and address, the name and address of any Subcontractor or supplier involved with the submittal, the date, and references to applicable Specification section(s) and/or drawing and detail number(s).

(D) **Required Corrections.** If corrections are required, Contractor must promptly make and submit any required corrections as specified in full conformance with the requirements of this Section, or other requirements that apply to that submittal.

(E) **Effect of Review and Acceptance.** Review and acceptance of a submittal by City will not relieve Contractor from complying with the requirements of the Contract Documents. Contractor is responsible for any errors in any submittal, and review or acceptance of a submittal by City is not an assumption of risk or liability by City.

(F) **Enforcement.** Any Work performed or any material furnished, installed, fabricated or used without City's prior acceptance of a required submittal is performed or provided at Contractor's risk, and Contractor may be required to bear the costs incident thereto, including the cost of removing and replacing such Work, repairs to other affected portions of the Work or material, and the cost of additional time or services required of City, including costs for the Design Professional, Project Manager, or Inspector.

(G) **Excessive RFIs.** A RFI will be considered excessive or unnecessary if City determines that the explanation or response to the RFI is clearly and unambiguously discernable from the Contract Documents. City's costs to review and respond to excessive or unnecessary RFIs may be deducted from payments otherwise due to Contractor.

2.6 Shop Drawings. When Shop Drawings are required by the Specifications or requested by the Engineer, they must be prepared according to best practices at Contractor's expense. The Shop Drawings must be of a size and scale to clearly show all necessary details. Unless otherwise specified by City, Shop Drawings must be provided to the Engineer for review and acceptance at least 30 days before the Work will be performed. If City requires changes, the corrected Shop Drawings must be resubmitted to the Engineer for review within the time specified by the Engineer. For all Project components

requiring Shop Drawings, Contractor will not furnish materials or perform any Work until the Shop Drawings for those components are accepted by City. Contractor is responsible for any errors or omissions in the Shop Drawings, shop fits and field corrections; any deviations from the Contract Documents; and for the results obtained by the use of Shop Drawings. Acceptance of Shop Drawings by City does not relieve Contractor of Contractor's responsibility.

- 2.7 Access to Work.** Contractor must afford prompt and safe access to any Worksite by City and its employees, agents, or consultants authorized by City; and upon request by City, Contractor must promptly arrange for City representatives to visit or inspect manufacturing sites or fabrication facilities for items to be incorporated into the Work.
- 2.8 Personnel.** Contractor and its Subcontractors must employ only competent and skillful personnel to perform the Work. Contractor and its Subcontractor's supervisors, security or safety personnel, and employees who have unescorted access to the Project site must possess proficiency in English sufficient to read, understand, receive, and implement oral or written communications or instructions relating to their respective job functions, including safety and security requirements. Upon written notification from the Engineer, Contractor and its Subcontractors must immediately discharge any personnel who are incompetent, disorderly, disruptive, threatening, abusive, or profane, or otherwise refuse or fail to comply with the requirements of the Contract Documents or Laws, including Laws pertaining to health and safety. Any such discharged personnel may not be re-employed or permitted on the Project in any capacity without City's prior written consent.

Article 3 - Contract Documents

3.1 Interpretation of Contract Documents.

(A) **Plans and Specifications.** The Plans and Specifications included in the Contract Documents are complementary. If Work is shown on one but not on the other, Contractor must perform the Work as though fully described on both, consistent with the Contract Documents and reasonably inferable from them as being necessary to produce the indicated results. The Plans and Specifications are deemed to include and require everything necessary and reasonably incidental to completion of the Work, whether or not particularly mentioned or shown. Contractor must perform all Work and services and supply all things reasonably related to and inferable from the Contract Documents. In the event of a conflict between the Plans and Specifications, the Specifications will control, unless the drawing(s) at issue are dated later than the Specification(s) at issue. Detailed drawings take precedence over general drawings, and large-scale drawings take precedence over smaller scale drawings. Any arrangement or division of the Plans and Specifications into sections is for convenience and is not intended to limit the Work required by separate trades. A conclusion presented in the Plans or Specifications is only a recommendation. Actual locations and depths must be determined by Contractor's field investigation. Contractor may request access to underlying or background information in City's possession that is necessary for Contractor to form its own conclusions.

(B) **Duty to Notify and Seek Direction.** If Contractor becomes aware of a changed condition in the Project, or of any ambiguity, conflict, inconsistency, discrepancy, omission, or error in the Contract Documents, including the Plans or Specifications, Contractor must promptly submit a Request for Information to the Engineer and wait for a response from City before proceeding further with the related Work. The RFI must notify City of the issue and request clarification, interpretation or direction. The Engineer's clarification, interpretation or direction will be final and binding on Contractor. If Contractor proceeds with the related Work before obtaining City's response, Contractor will be responsible for any resulting costs, including the cost of correcting any incorrect or

defective Work that results. Timely submission of a clear and complete RFI is essential to avoiding delay. Delay resulting from Contractor's failure to submit a timely and complete RFI to the Engineer is Non-Excusable Delay. If Contractor believes that City's response to an RFI justifies a change to the Contract Price or Contract Time, Contractor must perform the Work as directed, but may submit a timely Change Order request in accordance with the Contract Documents. (See Article 5 and 6.)

(C) **Figures and Dimensions.** Figures control over scaled dimensions.

(D) **Technical or Trade Terms.** Any terms that have well-known technical or trade meanings will be interpreted in accordance with those meanings, unless otherwise specifically defined in the Contract Documents.

(E) **Measurements.** Contractor must verify all relevant measurements in the Contract Documents and at the Project site before ordering any material or performing any Work, and will be responsible for the correctness of those measurements or for costs that could have been avoided by independently verifying measurements.

(F) **Compliance with Laws.** The Contract Documents are intended to comply with Laws and will be interpreted to comply with Laws.

3.2 Order of Precedence. Information included in one Contract Document but not in another will not be considered a conflict or inconsistency. Unless otherwise specified in the Special Conditions, in case of any conflict or inconsistency among the Contract Documents, the following order of precedence will apply, beginning from highest to lowest, with the most recent version taking precedent over an earlier version:

- (A) Change Orders;
- (B) Addenda;
- (C) Contract;
- (D) Notice to Proceed;
- (E) Attachment B – Federal Contract Requirements (only if used);
- (F) Special Conditions;
- (G) General Conditions;
- (H) Payment and Performance Bonds;
- (I) Specifications;
- (J) Plans;
- (K) Notice of Potential Award;
- (L) Notice Inviting Bids;
- (M) Attachment A – Federal Bidding Requirements (only if used);
- (N) Instructions to Bidders;
- (O) Contractor's Bid Proposal and attachments;
- (P) the City's standard specifications, as applicable; and
- (Q) Any generic documents prepared by and on behalf of a third party, that were not prepared specifically for this Project, such as the Caltrans Standard Specifications or Caltrans Special Provisions.

3.3 Caltrans Standard Specifications. Any reference to or incorporation of the Standard Specifications of the State of California, Department of Transportation ("Caltrans"), including "Standard Specifications," "Caltrans Specifications," "State Specifications," or "CSS," means the most current edition of Caltrans' Standard Specifications, unless otherwise specified ("Caltrans Standard Specifications"), including the most current amendments as of the date that Contractor's bid was submitted for this Project. The following provisions apply to use of or reference to the Caltrans Standard Specifications or Special Provisions:

(A) **Limitations.** The “General Provisions” of the Caltrans Standard Specifications, i.e., sections 1 through 9, do not apply to these Contract Documents with the exception of any specific provisions, if any, which are expressly stated to apply to these Contract Documents.

(B) **Conflicts or Inconsistencies.** If there is a conflict or inconsistency between any provision in the Caltrans Standard Specifications or Special Provisions and a provision of these Contract Documents, as determined by City, the provision in the Contract Documents will govern.

(C) **Meanings.** Terms used in the Caltrans Standard Specifications or Special Provisions are to be interpreted as follows:

(1) Any reference to the “Engineer” is deemed to mean the City Engineer.

(2) Any reference to the “Special Provisions” is deemed to mean the Special Conditions, unless the Caltrans Special Provisions are expressly included in the Contract Documents listed in Section 2 of the Contract.

(3) Any reference to the “Department” or “State” is deemed to mean City.

3.4 For Reference Only. Contractor is responsible for the careful review of any document, study, or report provided by City or appended to the Contract Documents solely for informational purposes and identified as “For Reference Only.” Nothing in any document, study, or report so appended and identified is intended to supplement, alter, or void any provision of the Contract Documents. Contractor is advised that City or its representatives may be guided by information or recommendations included in such reference documents, particularly when making determinations as to the acceptability of proposed materials, methods, or changes in the Work. Any record drawings or similar final or accepted drawings or maps that are not part of the Contract Documents are deemed to be For Reference Only. The provisions of the Contract Documents are not modified by any perceived or actual conflict with provisions in any document that is provided For Reference Only.

3.5 Current Versions. Unless otherwise specified by City, any reference to standard specifications, technical specifications, or any City or state codes or regulations means the latest specification, code or regulation in effect at the time the Contract is signed.

3.6 Conformed Copies. If City prepares a conformed set of the Contract Documents following award of the Contract, it will provide Contractor with two hard copy (paper) sets and one copy of the electronic file in PDF format. It is Contractor’s responsibility to ensure that all Subcontractors, including fabricators, are provided with the conformed set of the Contract Documents at Contractor’s sole expense.

3.7 Ownership. No portion of the Contract Documents may be used for any purpose other than construction of the Project, without prior written consent from City. Contractor is deemed to have conveyed the copyright in any designs, drawings, specifications, Shop Drawings, or other documents (in paper or electronic form) developed by Contractor for the Project, and City will retain all rights to such works, including the right to possession.

Article 4 - Bonds, Indemnity, and Insurance

4.1 Payment and Performance Bonds. Within ten days following issuance of the Notice of Potential Award, Contractor is required to provide a payment bond and a performance bond, each in the penal sum of not less than 100% of the Contract Price, and each

executed by Contractor and its surety using the bond forms included with the Contract Documents.

(A) **Surety.** Each bond must be issued and executed by a surety admitted in California. If an issuing surety cancels the bond or becomes insolvent, within seven days following written notice from City, Contractor must substitute a surety acceptable to City. If Contractor fails to substitute an acceptable surety within the specified time, City may, at its sole discretion, withhold payment from Contractor until the surety is replaced to City's satisfaction, or terminate the Contract for default.

(B) **Supplemental Bonds for Increase in Contract Price.** If the Contract Price increases during construction by five percent or more over the original Contract Price, Contractor must provide supplemental or replacement bonds within ten days of written notice from City pursuant to this Section, covering 100% of the increased Contract Price and using the bond forms included with the Contract Documents.

4.2 Indemnity. To the fullest extent permitted by law, Contractor must indemnify, defend, and hold harmless City, its Council, officers, officials, employees, agents, volunteers, and consultants (individually, an "Indemnitee," and collectively the "Indemnitees") from and against any and all liability, loss, damage, claims, causes of action, demands, charges, fines, costs, and expenses (including, without limitation, attorney fees, expert witness fees, paralegal fees, and fees and costs of litigation or arbitration) (collectively, "Liability") of every nature arising out of or in connection with the acts or omissions of Contractor, its employees, Subcontractors, representatives, or agents, in bidding or performing the Work or in failing to comply with any obligation of Contractor under the Contract, except such Liability caused by the active negligence, sole negligence, or willful misconduct of an Indemnitee. This indemnity requirement applies to any Liability arising from alleged defects in the content or manner of submission of Contractor's bid for the Contract. Contractor's failure or refusal to timely accept a tender of defense pursuant to this Contract will be deemed a material breach of the Contract. City will timely notify Contractor upon receipt of any third-party claim relating to the Contract, as required by Public Contract Code § 9201. Contractor waives any right to express or implied indemnity against any Indemnitee. Contractor's indemnity obligations under this Contract will survive the expiration or any early termination of the Contract.

4.3 Insurance. No later than ten days following issuance of the Notice of Potential Award, Contractor must procure and provide proof of the insurance coverage required by this Section in the form of certificates and endorsements acceptable to City. The required insurance must cover the activities of Contractor and its Subcontractors relating to or arising from the performance of the Work, and must remain in full force and effect at all times during the period covered by the Contract, through the date of City's acceptance of the Project. All required insurance must be issued by a company licensed to do business in the State of California, and each such insurer must have an A.M. Best's financial strength rating of "A" or better and a financial size rating of "VIII" or better. If Contractor fails to provide any of the required coverage in full compliance with the requirements of the Contract Documents, City may, at its sole discretion, purchase such coverage at Contractor's expense and deduct the cost from payments due to Contractor, or terminate the Contract for default. The procurement of the required insurance will not be construed to limit Contractor's liability under this Contract or to fulfill Contractor's indemnification obligations under this Contract.

(A) **Policies and Limits.** The following insurance policies and limits are required for this Contract, unless otherwise specified in the Special Conditions:

(1) *Commercial General Liability ("CGL") Insurance:* The CGL insurance policy must be issued on an occurrence basis, written on a comprehensive general

liability form, and must include coverage for liability arising from Contractor's or its Subcontractor's acts or omissions in the performance of the Work, including contractor's protected coverage, contractual liability, products and completed operations, and broad form property damage, with limits of at least \$2,000,000 per occurrence and at least \$4,000,000 general aggregate. The CGL insurance coverage may be arranged under a single policy for the full limits required or by a combination of underlying policies with the balance provided by excess or umbrella policies, provided each such policy complies with the requirements set forth in this Section, including required endorsements.

(2) *Automobile Liability Insurance*: The automobile liability insurance policy must provide coverage of at least \$2,000,000 combined single-limit per accident for bodily injury, death, or property damage, including hired and non-owned auto liability.

(3) *Workers' Compensation Insurance and Employer's Liability*: The workers' compensation and employer's liability insurance policy must comply with the requirements of the California Labor Code, providing coverage of at least \$1,000,000 or as otherwise required by the statute. If Contractor is self-insured, Contractor must provide its Certificate of Permission to Self-Insure, duly authorized by the DIR.

(4) *Pollution Liability Insurance*: The pollution liability insurance policy must be issued on an occurrence basis, providing coverage of at least \$2,000,000 for all loss arising out of claims for bodily injury, death, property damage, or environmental damage caused by pollution conditions resulting from the Work.

(5) *Builder's Risk Insurance*: The builder's risk insurance policy must be issued on an occurrence basis, for all-risk or "all perils" coverage on a 100% completed value basis on the insurable portion of the Project for the benefit of City.

(B) **Notice.** Each certificate of insurance must state that the coverage afforded by the policy or policies will not be reduced, cancelled or allowed to expire without at least 30 days written notice to City, unless due to non-payment of premiums, in which case ten days written notice must be made to City.

(C) **Waiver of Subrogation.** Each required policy must include an endorsement providing that the carrier will waive any right of subrogation it may have against City.

(D) **Required Endorsements.** The CGL policy, automobile liability policy, pollution liability policy, and builder's risk policy must include the following specific endorsements:

(1) The City, including its Council, officials, officers, employees, agents, volunteers and consultants (collectively, "Additional Insured") must be named as an additional insured for all liability arising out of the operations by or on behalf of the named insured, and the policy must protect the Additional Insured against any and all liability for personal injury, death or property damage or destruction arising directly or indirectly in the performance of the Contract. The additional insured endorsement must be provided using ISO form CG 20 10 11 85 or an equivalent form approved by the City.

(2) The inclusion of more than one insured will not operate to impair the rights of one insured against another, and the coverages afforded will apply as though separate policies have been issued to each insured.

(3) The insurance provided by Contractor is primary and no insurance held or owned by any Additional Insured may be called upon to contribute to a loss.

(4) This policy does not exclude explosion, collapse, underground excavation hazard, or removal of lateral support.

(E) **Contractor's Responsibilities.** This Section 4.3 establishes the minimum requirements for Contractor's insurance coverage in relation to this Project, but is not intended to limit Contractor's ability to procure additional or greater coverage. Contractor is responsible for its own risk assessment and needs and is encouraged to consult its insurance provider to determine what coverage it may wish to carry beyond the minimum requirements of this Section. Contractor is solely responsible for the cost of its insurance coverage, including premium payments, deductibles, or self-insured retentions, and no Additional Insured will be responsible or liable for any of the cost of Contractor's insurance coverage.

(F) **Deductibles and Self-Insured Retentions.** Any deductibles or self-insured retentions that apply to the required insurance (collectively, "deductibles") in excess of \$100,000 are subject to approval by the City's Risk Manager, acting in his or her sole discretion, and must be declared by Contractor when it submits its certificates of insurance and endorsements pursuant to this Section 4.3. If the City's Risk Manager determines that the deductibles are unacceptably high, at City's option, Contractor must either reduce or eliminate the deductibles as they apply to City and all required Additional Insured; or must provide a financial guarantee, to City's satisfaction, guaranteeing payment of losses and related investigation, claim administration, and legal expenses.

(G) **Subcontractors.** Contractor must ensure that each Subcontractor is required to maintain the same insurance coverage required under this Section 4.3, with respect to its performance of Work on the Project, including those requirements related to the Additional Insureds and waiver of subrogation, but excluding pollution liability or builder's risk insurance unless otherwise specified in the Special Conditions. A Subcontractor may be eligible for reduced insurance coverage or limits, but only to the extent approved in writing in advance by the City's Risk Manager. Contractor must confirm that each Subcontractor has complied with these insurance requirements before the Subcontractor is permitted to begin Work on the Project. Upon request by the City, Contractor must provide certificates and endorsements submitted by each Subcontractor to prove compliance with this requirement. The insurance requirements for Subcontractors do not replace or limit the Contractor's insurance obligations.

Article 5 - Contract Time

5.1 Time is of the Essence. Time is of the essence in Contractor's performance and completion of the Work, and Contractor must diligently prosecute the Work and complete it within the Contract Time.

(A) **General.** Contractor must commence the Work on the date indicated in the Notice to Proceed and must fully complete the Work in strict compliance with all requirements of the Contract Documents and within the Contract Time. Contractor may not begin performing the Work before the date specified in the Notice to Proceed.

(B) **Authorization.** Contractor is not entitled to compensation or credit for any Work performed before the date specified in the Notice to Proceed, with the exception of any schedules, submittals, or other requirements, if any, that must be provided or performed before issuance of the Notice to Proceed.

(C) **Rate of Progress.** Contractor and its Subcontractors must, at all times, provide workers, materials, and equipment sufficient to maintain the rate of progress necessary to ensure full completion of the Work within the Contract Time. If City determines that Contractor is failing to prosecute the Work at a sufficient rate of progress, City may, in its sole discretion, direct Contractor to provide additional workers, materials, or equipment, or to work additional hours or days without additional cost to City, in order to achieve a rate of progress satisfactory to City. If Contractor fails to comply with City's directive in this regard, City may, at Contractor's expense, separately contract for additional workers, materials, or equipment or use City's own forces to achieve the necessary rate of progress. Alternatively, City may terminate the Contract based on Contractor's default.

5.2 Schedule Requirements. Contractor must prepare all schedules using standard, commercial scheduling software acceptable to the Engineer, and must provide the schedules in electronic and paper form as requested by the Engineer. In addition to the general scheduling requirements set forth below, Contractor must also comply with any scheduling requirements included in the Special Conditions or in the Technical Specifications.

(A) **Baseline (As-Planned) Schedule.** Within ten calendar days following City's issuance of the Notice to Proceed (or as otherwise specified in the Notice to Proceed), Contractor must submit to City for review and acceptance a baseline (as-planned) schedule using critical path methodology showing in detail how Contractor plans to perform and fully complete the Work within the Contract Time, including labor, equipment, materials and fabricated items. The baseline schedule must show the order of the major items of Work and the dates of start and completion of each item, including when the materials and equipment will be procured. The schedule must also include the work of all trades, reflecting anticipated labor or crew hours and equipment loading for the construction activities, and must be sufficiently comprehensive and detailed to enable progress to be monitored on a day-by-day basis. For each activity, the baseline schedule must be dated, provided in the format specified in the Contract Documents or as required by City, and must include, at a minimum, a description of the activity, the start and completion dates of the activity, and the duration of the activity.

(1) **Specialized Materials Ordering.** Within five calendar days following issuance of the Notice to Proceed, Contractor must order any specialized material or equipment for the Work that is not readily available from material suppliers. Contractor must also retain documentation of the purchase order date(s).

(B) **City's Review of Schedules.** City will review and may note exceptions to the baseline schedule, and to the progress schedules submitted as required below, to assure completion of the Work within the Contract Time. Contractor is solely responsible for resolving any exceptions noted in a schedule and, within seven days, must correct the schedule to address the exceptions. City's review or acceptance of Contractor's schedules will not operate to waive or limit Contractor's duty to complete the Project within the Contract Time, nor to waive or limit City's right to assess liquidated damages for Contractor's unexcused failure to do so.

(C) **Progress Schedules.** After City accepts the final baseline schedule with no exceptions, Contractor must submit an updated progress schedule and three-week look-ahead schedule, in the format specified by City, for review and acceptance with each application for a progress payment, or when otherwise specified by City, until completion of the Work. The updated progress schedule must: show how the actual progress of the Work as constructed to date compares to the baseline schedule; reflect any proposed changes in the construction schedule or method of operations, including to achieve Project milestones within the Contract Time; and identify any actual or potential impacts

to the critical path. Contractor must also submit periodic reports to City of any changes in the projected material or equipment delivery dates for the Project.

(1) *Float*. The progress schedule must show early and late completion dates for each task. The number of days between those dates will be designated as the "float." Any float belongs to the Project and may be allocated by the Engineer to best serve timely completion of the Project.

(2) *Failure to Submit Schedule*. Reliable, up-to-date schedules are essential to efficient and cost-effective administration of the Project and timely completion. If Contractor fails to submit a schedule within the time periods specified in this Section, or submits a schedule to which City has noted exceptions that are not corrected, City may withhold up to ten percent from payment(s) otherwise due to Contractor until the exceptions are resolved, the schedule is corrected and resubmitted, and City has accepted the schedule. In addition, Contractor's failure to comply with the schedule requirements in this Section 5.2 will be deemed a material default and a waiver of any claims for Excusable Delay or loss of productivity arising during any period when Contractor is out of compliance, subject only to the limits of Public Contract Code § 7102.

(D) **Recovery Schedule**. If City determines that the Work is more than one week behind schedule, within seven days following written notice of such determination, Contractor must submit a recovery schedule, showing how Contractor intends to perform and complete the Work within the Contract Time, based on actual progress to date.

(E) **Effect of Acceptance**. Contractor and its Subcontractors must perform the Work in accordance with the most current City-accepted schedule unless otherwise directed by City. City's acceptance of a schedule does not operate to extend the time for completion of the Work or any component of the Work, and will not affect City's right to assess liquidated damages for Contractor's unexcused delay in completing the Work within the Contract Time.

(F) **Posting**. Contractor must at all times prominently post a copy of the most current City-accepted progress or recovery schedule in its on-site office.

(G) **Reservation of Rights**. City reserves the right to direct the sequence in which the Work must be performed or to make changes in the sequence of the Work in order to facilitate the performance of work by City or others, or to facilitate City's use of its property. The Contract Time or Contract Price may be adjusted to the extent such changes in sequence actually increase or decrease Contractor's time or cost to perform the Work.

(H) **Authorized Working Days and Times**. Contractor is limited to working Monday through Friday, excluding holidays, during City's normal business hours, except as provided in the Special Conditions or as authorized in writing by City. City reserves the right to charge Contractor for additional costs incurred by City due to Work performed on days or during hours not expressly authorized in the Contract Documents, including reimbursement of costs incurred for inspection, testing, and construction management services.

5.3 Delay and Extensions of Contract Time.

(A) **Notice of Delay**. If Contractor becomes aware of any actual or potential delay affecting the critical path, Contractor must promptly notify the Engineer in writing, regardless of the nature or cause of the delay, so that City has a reasonable opportunity to mitigate or avoid the delay.

(B) **Excusable Delay.** The Contract Time may be extended if Contractor encounters "Excusable Delay," which is an unavoidable delay in completing the Work within the Contract Time due to causes completely beyond Contractor's control, and which Contractor could not have avoided or mitigated through reasonable care, planning, foresight, and diligence, provided that Contractor is otherwise fully performing its obligations under the Contract Documents. Grounds for Excusable Delay may include fire, natural disasters including earthquake or unusually severe weather, acts of terror or vandalism, epidemic, unforeseeable adverse government actions, unforeseeable actions of third parties, encountering unforeseeable hazardous materials, unforeseeable site conditions, or suspension for convenience under Article 13. The Contract Time will not be extended based on circumstances which will not unavoidably delay completing the Work within the Contract Time based on critical path analysis.

(C) **Weather Delays.** A "Weather Delay Day" is a Working Day during which Contractor and its forces, including Subcontractors, are unable to perform more than 40% of the critical path Work scheduled for that day due to adverse weather conditions which impair the ability to safely or effectively perform the scheduled critical path Work that day. Adverse weather conditions may include rain, saturated soil, and Project site clean-up required due to adverse weather. Determination of what constitutes critical path Work scheduled for that day will be based on the most current, City-approved schedule. Contractor will be entitled to a non-compensable extension of the Contract Time for each Weather Delay Day in excess of the normal Weather Delay Days within a given month as determined by reliable records, including monthly rainfall averages, for the preceding ten years (or as otherwise specified in the Special Conditions or Specifications).

(1) Contractor must fully comply with the applicable procedures in Articles 5 and 6 of the General Conditions regarding requests to modify the Contract Time.

(2) Contractor will not be entitled to an extension of time for a Weather Delay Day to the extent Contractor is responsible for concurrent delay on that day.

(3) Contractor must take reasonable steps to mitigate the consequences of Weather Delay Days, including prudent workforce management and protecting the Work, Project Site, materials, and equipment.

(D) **Non-Excusable Delay.** Delay which Contractor could have avoided or mitigated through reasonable care, planning, foresight and diligence is "Non-Excusable Delay." Contractor is not entitled to an extension of Contract Time or any compensation for Non-Excusable Delay, or for Excusable Delay that is concurrent with Non-Excusable Delay. Non-Excusable Delay includes delay caused by:

(1) weather conditions which are normal for the location of the Project, as determined by reliable records, including monthly rainfall averages, for the preceding ten years;

(2) Contractor's failure to order equipment and materials sufficiently in advance of the time needed for completion of the Work within the Contract Time;

(3) Contractor's failure to provide adequate notification to utility companies or agencies for connections or services necessary for completion of the Work within the Contract Time;

- (4) foreseeable conditions which Contractor could have ascertained from reasonably diligent inspection of the Project site or review of the Contract Documents or other information provided or available to Contractor;
- (5) Contractor's failure, refusal, or financial inability to perform the Work within the Contract Time, including insufficient funds to pay its Subcontractors or suppliers;
- (6) performance or non-performance by Contractor's Subcontractors or suppliers;
- (7) the time required to respond to excessive RFIs (see Section 2.5(G));
- (8) delayed submission of required submittals, or the time required for correction and resubmission of defective submittals;
- (9) time required for repair of, re-testing, or re-inspection of defective Work;
- (10) enforcement of Laws by City, or outside agencies with jurisdiction over the Work; or
- (11) City's exercise or enforcement of any of its rights or Contractor's duties pursuant to the Contract Documents, including correction of defective Work, extra inspections or testing due to non-compliance with Contract requirements, safety compliance, environmental compliance, or rejection and return of defective or deficient submittals.

(E) **Compensable Delay.** Pursuant to Public Contract Code § 7102, in addition to entitlement to an extension of Contract Time, Contractor is entitled to compensation for costs incurred due to delay caused solely by City, when that delay is unreasonable under the circumstances involved and not within the contemplation of the parties ("Compensable Delay"). Contractor is not entitled to an extension of Contract Time or recovery of costs for Compensable Delay that is concurrent with Non-Excusable Delay. Delay due to causes that are beyond the control of either City or Contractor, including Weather Delay Days, discovery of Historic or Archeological Items pursuant to Section 7.18, or the actions or inactions of third parties or other agencies, is not Compensable Delay, and will only entitle Contractor to an extension of time commensurate with the time lost due to such delay.

(F) **Recoverable Costs.** Contractor is not entitled to compensation for Excusable Delay unless it is Compensable Delay, as defined above. Contractor is entitled to recover only the actual, direct, reasonable, and substantiated costs ("Recoverable Costs") for each working day that the Compensable Delay prevents Contractor from proceeding with more than 50% of the critical path Work scheduled for that day, based on the most recent progress schedule accepted by City. Recoverable Costs will not include home office overhead or lost profit.

(G) **Request for Extension of Contract Time or Recoverable Costs.** A request for an extension of Contract Time or any associated Recoverable Costs must be submitted in writing to City within ten calendar days of the date the delay is first encountered, even if the duration of the delay is not yet known at that time, or any entitlement to the Contract Time extension or to the Recoverable Costs will be deemed waived. In addition to complying with the requirements of this Article 5, the request must be submitted in compliance with the Change Order request procedures in Article 6 below. Strict compliance with these requirements is necessary to ensure that any delay or consequences of delay may be mitigated as soon as possible, and to facilitate cost-

efficient administration of the Project and timely performance of the Work. Any request for an extension of Contract Time or Recoverable Costs that does not strictly comply with all of the requirements of Article 5 and Article 6 will be deemed waived.

(1) *Required Contents.* The request must include a detailed description of the cause(s) of the delay and must also describe the measures that Contractor has taken to mitigate the delay and/or its effects, including efforts to mitigate the cost impact of the delay, such as by workforce management or by a change in sequencing. If the delay is still ongoing at the time the request is submitted, the request should also include Contractor's plan for continued mitigation of the delay or its effects.

(2) *Delay Days and Costs.* The request must specify the number of days of Excusable Delay claimed or provide a realistic estimate if the duration of the delay is not yet known. If Contractor believes it is entitled to Recoverable Costs for Compensable Delay, the request must specify the amount and basis for the Recoverable Costs that are claimed or provide a realistic estimate if the amount is not yet known. Any estimate of delay duration or cost must be updated in writing and submitted with all required supporting documentation as soon as the actual time and cost is known. The maximum extension of Contract Time will be the number of days, if any, by which an Excusable Delay or a Compensable Delay exceeds any concurrent Non-Excusable Delay. Contractor is entitled to an extension of Contract Time, or compensation for Recoverable Costs, only if, and only to the extent that, such delay will unavoidably delay Final Completion.

(3) *Supporting Documentation.* The request must also include any and all supporting documentation necessary to evidence the delay and its actual impacts, including scheduling and cost impacts with a time impact analysis using critical path methodology and demonstrating the unavoidable delay to Final Completion. The time impact analysis must be submitted in a form or format acceptable to City.

(4) *Burden of Proof.* Contractor has the burden of proving that: the delay was an Excusable or Compensable Delay, as defined above; Contractor has fully complied with its scheduling obligations in Section 5.2, Schedule Requirements; Contractor has made reasonable efforts to mitigate the delay and its schedule and cost impacts; the delay will unavoidably result in delaying Final Completion; and any Recoverable Costs claimed by Contractor were actually incurred and were reasonable under the circumstances.

(5) *Legal Compliance.* Nothing in this Section 5.3 is intended to require the waiver, alteration, or limitation of the applicability of Public Contract Code § 7102.

(6) *No Waiver.* Any grant of an extension of Contract Time, or compensation for Recoverable Costs due to Compensable Delay, will not operate as a waiver of City's right to assess liquidated damages for Non-Excusable Delay.

(7) *Dispute Resolution.* In the event of a dispute over entitlement to an extension of Contract Time or compensation for Recoverable Costs, Contractor may not stop Work pending resolution of the dispute, but must continue to comply with its duty to diligently prosecute the performance and timely completion of the Work. Contractor's sole recourse for an unresolved dispute based on City's rejection of a Change Order request for an extension of Contract Time or compensation for Recoverable Costs is to comply with the dispute resolution provisions set forth in Article 12 below.

5.4 Liquidated Damages. It is expressly understood that if Final Completion is not achieved within the Contract Time, City will suffer damages from the delay that are difficult to determine and accurately specify. Pursuant to Public Contract Code § 7203, if Contractor fails to achieve Final Completion within the Contract Time due to Contractor's Non-Excusable Delay, City will charge Contractor in the amount specified in the Contract for each calendar day that Final Completion is delayed beyond the Contract Time, as liquidated damages and not as a penalty. Any waiver of accrued liquidated damages, in whole or in part, is subject to approval of the City Council or its authorized delegee.

(A) **Liquidated Damages.** Liquidated damages will not be assessed for any Excusable or Compensable Delay, as set forth above.

(B) **Milestones.** Liquidated damages may also be separately assessed for failure to meet milestones specified elsewhere in the Contract Documents.

(C) **Setoff.** City is entitled to deduct the amount of liquidated damages assessed against any payments otherwise due to Contractor, including progress payments, Final Payment, or unreleased retention. If there are insufficient Contract funds remaining to cover the full amount of liquidated damages assessed, City is entitled to recover the balance from Contractor or its performance bond surety.

(D) **Occupancy or Use.** Occupancy or use of the Project in whole or in part prior to Final Completion does not constitute City's acceptance of the Project and will not operate as a waiver of City's right to assess liquidated damages for Contractor's Non-Excusable Delay in achieving Final Completion.

(E) **Other Remedies.** City's right to liquidated damages under this Section applies only to damages arising from Contractor's Non-Excusable Delay or failure to complete the Work within the Contract Time. City retains its right to pursue all other remedies under the Contract for other types of damage, including damage to property or persons, costs or diminution in value from defective materials or workmanship, costs to repair or complete the Work, or other liability caused by Contractor.

Article 6 - Contract Modification

6.1 Contract Modification. Subject to the limited exception set forth in subsection (D) below, any change in the Work or the Contract Documents, including the Contract Price or Contract Time, will not be a valid and binding change to the Contract unless it is formalized in a Change Order, including a "no-cost" Change Order or a unilateral Change Order. Changes in the Work pursuant to this Article 6 will not operate to release, limit, or abridge Contractor's warranty obligations pursuant to Article 11 or any obligations of Contractor's bond sureties.

(A) **City-Directed Changes.** City may direct changes in the scope or sequence of Work or the requirements of the Contract Documents, without invalidating the Contract. Such changes may include Extra Work as set forth in subsection (C) below, or deletion or modification of portions of the Work. Contractor must promptly comply with City-directed changes in the Work in accordance with the original Contract Documents, even if Contractor and City have not yet reached agreement as to adjustments to the Contract Price or Contract Time for the change in the Work or for the Extra Work. Contractor is not entitled to extra compensation for cost savings resulting from "value engineering" pursuant to Public Contract Code § 7101, except to the extent authorized in advance by City in writing, and subject to any applicable procedural requirements for submitting a proposal for value engineering cost savings.

(B) **Disputes.** In the event of a dispute over entitlement to or the amount of a change in Contract Time or a change in Contract Price related to a City-directed change in the Work, Contractor must perform the Work as directed and may not delay its Work or cease Work pending resolution of the dispute, but must continue to comply with its duty to diligently prosecute the performance and timely completion of the Work, including the Work in dispute. Likewise, in the event that City and Contractor dispute whether a portion or portions of the Work are already required by the Contract Documents or constitute Extra Work, or otherwise dispute the interpretation of any portion(s) of the Contract Documents, Contractor must perform the Work as directed and may not delay its Work or cease Work pending resolution of the dispute, but must continue to comply with its duty to diligently prosecute the performance and timely completion of the Work, including the Work in dispute, as directed by City. If Contractor refuses to perform the Work in dispute, City may, acting in its sole discretion, elect to delete the Work from the Contract and reduce the Contract Price accordingly, and self-perform the Work or direct that the Work be performed by others. Alternatively, City may elect to terminate the Contract for convenience or for cause. Contractor's sole recourse for an unresolved dispute related to changes in the Work or performance of any Extra Work is to comply with the dispute resolution provisions set forth in Article 12, below.

(C) **Extra Work.** City may direct Contractor to perform Extra Work related to the Project. Contractor must promptly perform any Extra Work as directed or authorized by City in accordance with the original Contract Documents, even if Contractor and City have not yet reached agreement on adjustments to the Contract Price or Contract Time for such Extra Work. If Contractor believes it is necessary to perform Extra Work due to changed conditions, Contractor must promptly notify the Engineer in writing, specifically identifying the Extra Work and the reason(s) the Contractor believes it is Extra Work. This notification requirement does not constitute a Change Order request pursuant to Section 6.2, below. Contractor must maintain detailed daily records that itemize the cost of each element of Extra Work, and sufficiently distinguish the direct cost of the Extra Work from the cost of other Work performed. For each day that Contractor performs Extra Work, or Work that Contractor contends is Extra Work, Contractor must submit no later than the following Working Day, a daily report of the Extra Work performed that day and the related costs, together with copies of certified payroll, invoices, and other documentation substantiating the costs ("Extra Work Report"). The Engineer will make any adjustments to Contractor's Extra Work Report(s) based on the Engineer's records of the Work. When an Extra Work Report(s) is agreed on and signed by both City and Contractor, the Extra Work Report(s) will become the basis for payment under a duly authorized and signed Change Order. Failure to submit the required documentation by close of business on the next Working Day is deemed a full and complete waiver for any change in the Contract Price or Contract Time for any Extra Work performed that day.

(D) **Minor Changes and RFIs.** Minor field changes, including RFI replies from City, that do not affect the Contract Price or Contract Time and that are approved by the Engineer acting within his or her scope of authority, do not require a Change Order. By executing an RFI reply from City, Contractor agrees that it will perform the Work as clarified therein, with no change to the Contract Price or Contract Time.

(E) **Remedy for Non-Compliance.** Contractor's failure to promptly comply with a City-directed change is deemed a material breach of the Contract, and in addition to all other remedies available to it, City may, at its sole discretion, hire another contractor or use its own forces to complete the disputed Work at Contractor's sole expense, and may deduct the cost from the Contract Price.

6.2 Contractor Change Order Requests. Contractor must submit a request or proposal for a change in the Work, compensation for Extra Work, or a change in the Contract Price or Contract Time as a written Change Order request or proposal.

(A) **Time for Submission.** Any request for a change in the Contract Price or the Contract Time must be submitted in writing to the Engineer within ten calendar days of the date that Contractor first encounters the circumstances, information or conditions giving rise to the Change Order request, even if the total amount of the requested change in the Contract Price or impact on the Contract Time is not yet known at that time. If City requests that Contractor propose the terms of a Change Order, unless otherwise specified in City's request, Contractor must provide the Engineer with a written proposal for the change in the Contract Price or Contract Time within five working days of receiving City's request, in a form satisfactory to the Engineer.

(B) **Required Contents.** Any Change Order request or proposal submitted by Contractor must include a complete breakdown of actual or estimated costs and credits, and must itemize labor, materials, equipment, taxes, insurance, subcontract amounts, and, if applicable, Extra Work Reports. Any estimated cost must be updated in writing as soon as the actual amount is known.

(C) **Required Documentation.** All claimed costs must be fully documented, and any related request for an extension of time or delay-related costs must be included at that time and in compliance with the requirements of Article 5 of the General Conditions. Upon request, Contractor must permit City to inspect its original and unaltered bidding records, subcontract agreements, subcontract change orders, purchase orders, invoices, or receipts associated with the claimed costs.

(D) **Required Form.** Contractor must use City's form(s) for submitting all Change Order requests or proposals, unless otherwise specified by City.

(E) **Certification.** All Change Order requests must be signed by Contractor and must include the following certification:

"The undersigned Contractor certifies under penalty of perjury that its statements and representations in this Change Order request are true and correct. Contractor warrants that this Change Order request is comprehensive and complete as to the Work or changes referenced herein, and agrees that any known or foreseeable costs, expenses, or time extension requests not included herein, are deemed waived."

6.3 Adjustments to Contract Price. The amount of any increase or decrease in the Contract Price will be determined based on one of the following methods listed below, in the order listed with unit pricing taking precedence over the other methods. Markup applies only to City-authorized time and material Work, and does not apply to any other payments to Contractor. For Work items or components that are deleted in their entirety, Contractor will only be entitled to compensation for those direct, actual, and documented costs (including restocking fees), reasonably incurred before Contractor was notified of the City's intent to delete the Work, with no markup for overhead, profit, or other indirect costs.

(A) **Unit Pricing.** Amounts previously provided by Contractor in the form of unit prices, either in a bid schedule or in a post-award schedule of values pursuant to Section 8.1, Schedule of Values, will apply to determine the price for the affected Work, to the extent applicable unit prices have been provided for that type of Work. No additional markup for overhead, profit, or other indirect costs will be added to the calculation.

(B) **Lump Sum.** A mutually agreed upon, all-inclusive lump sum price for the affected Work with no additional markup for overhead, profit, or other indirect costs.

(C) **Time and Materials.** On a time and materials basis, if and only to the extent compensation on a time and materials basis is expressly authorized by City in advance of Contractor's performance of the Work and subject to any not-to-exceed limit. Time and materials compensation for increased costs or Extra Work (but not decreased costs or deleted Work), will include allowed markup for overhead, profit, and other indirect costs, calculated as the total of the following sums, the cumulative total of which may not exceed the maximum markup rate of 15%:

- (1) All direct labor costs provided by the Contractor, excluding superintendence, project management, or administrative costs, plus 15% markup;
- (2) All direct material costs provided by the Contractor, including sales tax, plus 15% markup;
- (3) All direct plant and equipment rental costs provided by the Contractor, plus 15% markup;
- (4) All direct additional subcontract costs plus 10% markup for Work performed by Subcontractors; and
- (5) Increased bond or insurance premium costs computed at 1.5% of total of the previous four sums.

6.4 Unilateral Change Order. If the parties dispute the terms of a proposed Change Order, including disputes over the amount of compensation or extension of time that Contractor has requested, the value of deleted or changed Work, what constitutes Extra Work, or quantities used, City may elect to issue a unilateral Change Order, directing performance of the Work, and authorizing a change in the Contract Price or Contract Time for the adjustment to compensation or time that the City believes is merited. Contractor's sole recourse to dispute the terms of a unilateral Change Order is to submit a timely Claim pursuant to Article 12, below.

6.5 Non-Compliance Deemed Waiver. Contractor waives its entitlement to any increase in the Contract Price or Contract Time if Contractor fails to fully comply with the provisions of this Article. Contractor will not be paid for unauthorized Extra Work.

Article 7 - General Construction Provisions

7.1 Permits, Fees, Business License, and Taxes.

(A) **Permits, Fees, and City Business License.** Contractor must obtain and pay for all permits, fees, or licenses required to perform the Work, including a City business license. Contractor must cooperate with and provide notifications to all government agencies with jurisdiction over the Project, as may be required. Contractor must provide City with copies of all records of permits and permit applications, payment of required fees, and any licenses required for the Work.

(B) **Taxes.** Contractor must pay for all taxes on labor, material and equipment, except Federal Excise Tax to the extent that City is exempt from Federal Excise Tax.

7.2 Temporary Facilities. Contractor must provide, at Contractor's sole expense, any and all temporary facilities for the Project, including an onsite staging area for materials and equipment, a field office, sanitary facilities, utilities, storage, scaffolds, barricades, walkways, and any other temporary structure required to safely perform the Work along with any incidental utility services. The location of all temporary facilities must be

approved by the City prior to installation. Temporary facilities must be safe and adequate for the intended use and installed and maintained in accordance with Laws and the Contract Documents. Contractor must fence and screen the Project site and, if applicable, any separate Worksites, including the staging area, and its operation must minimize inconvenience to neighboring properties. Additional provisions pertaining to temporary facilities may be included in the Specifications or Special Conditions.

(A) **Utilities.** Contractor must install and maintain the power, water, sewer and all other utilities required for the Project site, including the piping, wiring, internet and wifi connections, and any related equipment necessary to maintain the temporary facilities.

(B) **Removal and Repair.** Contractor must promptly remove all such temporary facilities when they are no longer needed or upon completion of the Work, whichever comes first. Contractor must promptly repair any damage to City's property or to other property caused by the installation, use, or removal of the temporary facilities, and must promptly restore the property to its original or intended condition.

7.3 Noninterference and Site Management. Contractor must avoid interfering with City's use of its property at or adjacent to the Project site, including use of roadways, entrances, parking areas, walkways, and structures. Contractor must also minimize disruption of access to private property in the Project vicinity. Contractor must coordinate with affected property owners, tenants, and businesses, and maintain some vehicle and pedestrian access to their residences or properties at all times. Temporary access ramps, fencing or other measures must be provided as needed. Before blocking access to a private driveway or parking lot, Contractor must provide effective notice to the affected parties at least 48 hours in advance of the pending closure and allow them to remove vehicles. Private driveways, residences and parking lots must have access to a roadway during non-Work hours.

(A) **Offsite Acquisition.** Unless otherwise provided by City, Contractor must acquire, use and dispose of, at its sole expense, any Worksites, licenses, easements, and temporary facilities necessary to access and perform the Work.

(B) **Offsite Staging Area and Field Office.** If additional space beyond the Project site is needed, such as for the staging area or the field office, Contractor may need to make arrangements with the nearby property owner(s) to secure the space. Before using or occupying any property owned by a third party, Contractor must provide City with a copy of the necessary license agreement, easement, or other written authorization from the property owner, together with a written release from the property owner holding City harmless from any related liability, in a form acceptable to the City Attorney.

(C) **Traffic Management.** Contractor must provide traffic management and traffic controls as specified in the Contract Documents, as required by Laws, and as otherwise required to ensure public and worker safety, and to avoid interference with public or private operations or the normal flow of vehicular, bicycle, or pedestrian traffic.

7.4 Signs. No signs may be displayed on or about City's property, except signage which is required by Laws or by the Contract Documents, without City's prior written approval as to size, design, and location.

7.5 Project Site and Nearby Property Protections.

(A) **General.** Contractor is responsible at all times, on a 24-hour basis and at its sole cost, for protecting the Work, the Project site, and the materials and equipment to be incorporated into the Work, until the City has accepted the Project, excluding any exceptions to acceptance, if any. Except as specifically authorized by City, Contractor

must confine its operations to the area of the Project site indicated in the Plans and Specifications. Contractor is liable for any damage caused by Contractor or its Subcontractors to the Work, City's property, the property of adjacent or nearby property owners and the work or personal property of other contractors working for City, including damage related to Contractor's failure to adequately secure the Work or any Worksite.

(1) Subject to City's approval, Contractor will provide and install safeguards to protect the Work; any Worksite, including the Project site; City's real or personal property and the real or personal property of adjacent or nearby property owners, including plant and tree protections.

(2) City wastewater systems may not be interrupted. If the Work disrupts existing sewer facilities, Contractor must immediately notify City and establish a plan, subject to City's approval, to convey the sewage in closed conduits back into the sanitary sewer system. Sewage must not be permitted to flow in trenches or be covered by backfill.

(3) Contractor must remove with due care, and store at City's request, any objects or material from the Project site that City will salvage or reuse at another location.

(4) If directed by Engineer, Contractor must promptly repair or replace any property damage, as specified by the Engineer. However, acting in its sole discretion, City may elect to have the property damage remedied otherwise, and may deduct the cost to repair or replace the damaged property from payment otherwise due to Contractor.

(5) Contractor will not permit any structure or infrastructure to be loaded in a manner that will damage or endanger the integrity of the structure or infrastructure.

(B) **Securing Project Site.** After completion of Work each day, Contractor must secure the Project site and, to the extent feasible, make the area reasonably accessible to the public unless City approves otherwise. All excess materials and equipment not protected by approved traffic control devices must be relocated to the staging area or demobilized. Trench spoils must be hauled off the Project site daily and open excavations must be protected with steel plates. Contractor and Subcontractor personnel may not occupy or use the Project site for any purpose during non-Work hours, except as may be provided in the Contract Documents or pursuant to prior written authorization from City.

(C) **Unforeseen Conditions.** If Contractor encounters facilities, utilities, or other unknown conditions not shown on or reasonably inferable from the Plans or apparent from inspection of the Project site, Contractor must immediately notify the City and promptly submit a Request for Information to obtain further directions from the Engineer. Contractor must avoid taking any action which could cause damage to the facilities or utilities pending further direction from the Engineer. The Engineer's written response will be final and binding on Contractor. If the Engineer's subsequent direction to Contractor affects Contractor's cost or time to perform the Work, Contractor may submit a Change Order request as set forth in Article 6 above.

(D) **Support; Adjacent Properties.** Contractor must provide, install, and maintain all shoring, bracing, and underpinning necessary to provide support to City's property and adjacent properties and improvements thereon. Contractor must provide notifications to adjacent property owners as may be required by Laws. See also, Section 7.15, Trenching of Five Feet or More.

(E) **Notification of Property Damage.** Contractor must immediately notify the City of damage to any real or personal property resulting from Work on the Project. Contractor must immediately provide a written report to City of any such property damage in excess of \$500 (based on estimated cost to repair or replace) within 24 hours of the occurrence. The written report must include: (1) the location and nature of the damage, and the owner of the property, if known; (2) the name and address of each employee of Contractor or any Subcontractor involved in the damage; (3) a detailed description of the incident, including precise location, time, and names and contact information for known witnesses; and (4) a police or first responder report, if applicable. If Contractor is required to file an accident report with another government agency, Contractor will provide a copy of the report to City.

7.6 Materials and Equipment.

(A) **General.** Unless otherwise specified, all materials and equipment required for the Work must be new, free from defects, and of the best grade for the intended purpose, and furnished in sufficient quantities to ensure the proper and expeditious performance of the Work. Contractor must employ measures to preserve the specified quality and fitness of the materials and equipment. Unless otherwise specified, all materials and equipment required for the Work are deemed to include all components required for complete installation and intended operation and must be installed in accordance with the manufacturer's recommendations or instructions. Contractor is responsible for all shipping, handling, and storage costs associated with the materials and equipment required for the Work. Contractor is responsible for providing security and protecting the Work and all of the required materials, supplies, tools and equipment at Contractor's sole cost until City has formally accepted the Project as set forth in Section 11.1, Final Completion. Contractor will not assign, sell, mortgage, or hypothecate any materials or equipment for the Project, or remove any materials or equipment that have been installed or delivered.

(B) **City-Provided.** If the Work includes installation of materials or equipment to be provided by City, Contractor is solely responsible for the proper examination, handling, storage, and installation in accordance with the Contract Documents. Contractor must notify City of any defects discovered in City-provided materials or equipment, sufficiently in advance of scheduled use or installation to afford adequate time to procure replacement materials or equipment as needed. Contractor is solely responsible for any loss of or damage to such items which occurs while the items are in Contractor's custody and control, the cost of which may be offset from the Contract Price and deducted from any payment(s) due to Contractor.

(C) **Intellectual Property Rights.** Contractor must, at its sole expense, obtain any authorization or license required for use of patented or copyright-protected materials, equipment, devices or processes that are incorporated into the Work. Contractor's indemnity obligations in Article 4 apply to any claimed violation of intellectual property rights in violation of this provision.

7.7 Substitutions.

(A) **"Or Equal."** Any Specification designating a material, product, or thing (collectively, "item") or service by specific brand or trade name, followed by the words "or equal," is intended only to indicate the quality and type of item or service desired, and Contractor may request use of any equal item or service. Unless otherwise stated in the Specifications, any reference to a specific brand or trade name for an item or service that is used solely for the purpose of describing the type of item or service desired, will be deemed to be followed by the words "or equal." A substitution will only be approved if it is a true "equal" item or service in every aspect of design, function, and quality, as

determined by City, including dimensions, weight, maintenance requirements, durability, fit with other elements, and schedule impacts.

(B) **Request for Substitution.** A post-award request for substitution of an item or service must be submitted in writing to the Engineer for approval in advance, within the applicable time period provided in the Contract Documents. If no time period is specified, the substitution request may be submitted any time within 35 days after the date of award of the Contract, or sufficiently in advance of the time needed to avoid delay of the Work, whichever is earlier.

(C) **Substantiation.** Any available data substantiating the proposed substitute as an equal item or service must be submitted with the written request for substitution. Contractor's failure to timely provide all necessary substantiation, including any required test results as soon as they are available, is grounds for rejection of the proposed substitution, without further review.

(D) **Burden of Proving Equality.** Contractor has the burden of proving the equality of the proposed substitution at Contractor's sole cost. City has sole discretion to determine whether a proposed substitution is equal, and City's determination is final.

(E) **Approval or Rejection.** If the proposed substitution is approved, Contractor is solely responsible for any additional costs or time associated with the substituted item or service. If the proposed substitution is rejected, Contractor must, without delay, install the item or use the service as specified by City.

(F) **Contractor's Obligations.** City's approval of a proposed substitution will not relieve Contractor from any of its obligations under the Contract Documents. In the event Contractor makes an unauthorized substitution, Contractor will be solely responsible for all resulting cost impacts, including the cost of removal and replacement and the impact to other design elements.

7.8 Testing and Inspection.

(A) **General.** All materials, equipment, and workmanship used in the Work are subject to inspection and testing by City at all times and locations during construction and/or fabrication and at any Worksite, including at shops and yards as well as at the Project site. All manufacturers' application or installation instructions must be provided to the Inspector at least ten days prior to the first such application or installation. Contractor must, at all times, make the Work available for testing or inspection. Neither City's inspection or testing of Work, nor its failure to do so, operate to waive or limit Contractor's duty to complete the Work in accordance with the Contract Documents.

(B) **Scheduling and Notification.** Contractor must cooperate with City in coordinating the inspections and testing. Contractor must submit samples of materials, at Contractor's expense, and schedule all tests required by the Contract Documents in time to avoid any delay to the progress of the Work. Contractor must notify the Engineer no later than noon of the Working Day before any inspection or testing and must provide timely notice to the other necessary parties as specified in the Contract Documents. If Contractor schedules an inspection or test beyond regular Work hours, or on a Saturday, Sunday, or recognized City holiday, Contractor must notify the Engineer at least two Working Days in advance for approval. If approved, Contractor must reimburse City for the cost of the overtime inspection or testing. Such costs, including the City's hourly costs for required personnel, may be deducted from payments otherwise due to Contractor.

(C) **Responsibility for Costs.** City will bear the initial cost of inspection and testing to be performed by independent testing consultants retained by City, subject to the following exceptions:

(1) Contractor will be responsible for the costs of any subsequent tests which are required to substantiate compliance with the Contract Documents, and any associated remediation costs.

(2) Contractor will be responsible for inspection costs, at City's hourly rates, for inspection time lost because the Work is not ready or Contractor fails to appear for a scheduled inspection.

(3) If any portion of the Work that is subject to inspection or testing is covered or concealed by Contractor prior to the inspection or testing, Contractor will bear the cost of making that portion of the Work available for the inspection or testing required by the Contract Documents, and any associated repair or remediation costs.

(4) Contractor is responsible for properly shoring all compaction test sites deeper than five feet below grade, as required under Section 7.15 below.

(5) Any Work or material that is defective or fails to comply with the requirements of the Contract Documents must be promptly repaired, removed, replaced, or corrected by Contractor, at Contractor's sole expense, even if that Work or material was previously inspected or included in a progress payment.

(D) **Contractor's Obligations.** Contractor is solely responsible for any delay occasioned by remediation of defective or noncompliant Work or material. Inspection of the Work does not in any way relieve Contractor of its obligations to perform the Work as specified. Any Work done without the required inspection(s) will also be subject to rejection by City.

(E) **Distant Locations.** If required off-site testing or inspection must be conducted at a location more than 100 miles from the Project site, Contractor is solely responsible for the additional travel costs required for testing and/or inspection at such locations.

(F) **Final Inspection.** The provisions of this Section 7.8 also apply to final inspection under Article 11, Completion and Warranty Provisions.

7.9 Project Site Conditions and Maintenance. Contractor must at all times, on a 24-hour basis and at its sole cost, maintain the Project site and staging and storage areas in clean, neat, and sanitary condition and in compliance with all Laws pertaining to safety, air quality, and dust control. Adequate toilets must be provided, and properly maintained and serviced for all workers on the Project site, located in a suitably secluded area, subject to City's prior approval. Contractor must also, on a daily basis and at its sole cost, remove and properly dispose of the debris and waste materials from the Project site.

(A) **Air Emissions Control.** Contractor must not discharge smoke or other air contaminants into the atmosphere in violation of any Laws.

(B) **Dust and Debris.** Contractor must minimize and confine dust and debris resulting from the Work. Contractor must abate dust nuisance by cleaning, sweeping, and immediately sprinkling with water excavated areas of dirt or other materials prone to cause dust, and within one hour after the Engineer notifies Contractor that an airborne nuisance exists. The Engineer may direct that Contractor provide an approved water-spraying truck for this purpose. If water is used for dust control, Contractor will only use

the minimum necessary. Contractor must take all necessary steps to keep waste water out of streets, gutters, or storm drains. See Section 7.19, Environmental Control. If City determines that the dust control is not adequate, City may have the work done by others and deduct the cost from the Contract Price. Contractor will immediately remove any excess excavated material from the Project site and any dirt deposited on public streets.

(C) **Clean up.** Before discontinuing Work in an area, Contractor must clean the area and remove all debris and waste along with the construction equipment, tools, machinery, and surplus materials.

(1) Except as otherwise specified, all excess Project materials, and the materials removed from existing improvements on the Project site with no salvage value or intended reuse by City, will be Contractor's property.

(2) Hauling trucks and other vehicles leaving the Project site must be cleaned of exterior mud or dirt before traveling on City streets. Materials and loose debris must be delivered and loaded to prevent dropping materials or debris. Contractor must immediately remove spillage from hauling on any publicly traveled way. Streets affected by Work on the Project must be kept clean by street sweeping.

(D) **Disposal.** Contractor must dispose of all Project debris and waste materials in a safe and legal manner. Contractor may not burn or bury waste materials on the Project site. Contractor will not allow any dirt, refuse, excavated material, surplus concrete or mortar, or any associated washings, to be disposed of onto streets, into manholes or into the storm drain system.

(E) **Completion.** At the completion of the Work, Contractor must remove from the Project site all of its equipment, tools, surplus materials, waste materials and debris, presenting a clean and neat appearance. Before demobilizing from the Project site, Contractor must ensure that all surfaces are cleaned, sealed, waxed, or finished as applicable, and that all marks, stains, paint splatters, and the like have been properly removed from the completed Work and the surrounding areas. Contractor must ensure that all parts of the construction are properly joined with the previously existing and adjacent improvements and conditions. Contractor must provide all cutting, fitting and patching needed to accomplish that requirement. Contractor must also repair or replace all existing improvements that are damaged or removed during the Work, both on and off the Project site, including curbs, sidewalks, driveways, fences, signs, utilities, street surfaces and structures. Repairs and replacements must be at least equal to the previously existing improvements, and the condition, finish and dimensions must match the previously existing improvements. Contractor must restore to original condition all property or items that are not designated for alteration under the Contract Documents and leave each Worksite clean and ready for occupancy or use by City.

(F) **Non-Compliance.** If Contractor fails to comply with its maintenance and cleanup obligations or any City clean up order, City may, acting in its sole discretion, elect to suspend the Work until the condition(s) is corrected with no increase in the Contract Time or Contract Price, or undertake appropriate cleanup measures without further notice and deduct the cost from any amounts due or to become due to Contractor.

7.10 Instructions and Manuals. Contractor must provide to City three copies each of all instructions and manuals required by the Contract Documents, unless otherwise specified. These must be complete as to drawings, details, parts lists, performance data, and other information that may be required for City to easily maintain and service the materials and equipment installed for this Project.

(A) **Submittal Requirements.** All manufacturers' application or installation instructions must be provided to City at least ten days prior to the first such application. The instructions and manuals, along with any required guarantees, must be delivered to City for review.

(B) **Training.** Contractor or its Subcontractors must train City's personnel in the operation and maintenance of any complex equipment or systems as a condition precedent to Final Completion, if required in the Contract Documents.

7.11 As-built Drawings. Contractor and its Subcontractors must prepare and maintain at the Project site a detailed, complete and accurate as-built set of the Plans which will be used solely for the purpose of recording changes made in any portion of the original Plans in order to create accurate record drawings at the end of the Project.

(A) **Duty to Update.** The as-built drawings must be updated as changes occur, on a daily basis if necessary. City may withhold the estimated cost for City to have the as-built drawings prepared from payments otherwise due to Contractor, until the as-built drawings are brought up to date to the satisfaction of City. Actual locations to scale must be identified on the as-built drawings for all runs of mechanical and electrical work, including all site utilities installed underground, in walls, floors, or otherwise concealed. Deviations from the original Plans must be shown in detail. The exact location of all main runs, whether piping, conduit, ductwork or drain lines, must be shown by dimension and elevation. The location of all buried pipelines, appurtenances, or other improvements must be represented by coordinates and by the horizontal distance from visible above-ground improvements.

(B) **Final Completion.** Contractor must verify that all changes in the Work are depicted in the as-built drawings and must deliver the complete set of as-built drawings to the Engineer for review and acceptance as a condition precedent to Final Completion and Final Payment.

7.12 Existing Utilities.

(A) **General.** The Work may be performed in developed, urban areas with existing utilities, both above and below ground, including utilities identified in the Contract Documents or in other informational documents or records. Contractor must take due care to locate identified or reasonably identifiable utilities before proceeding with trenching, excavation, or any other activity that could damage or disrupt existing utilities. This may include excavation with small equipment, potholing, or hand excavation, and, if practical, using white paint or other suitable markings to delineate the area to be excavated. Except as otherwise provided herein, Contractor will be responsible for costs resulting from damage to identified or reasonably identifiable utilities due to Contractor's negligence or failure to comply with the Contract Documents, including the requirements in this Article 7.

(B) **Unidentified Utilities.** Pursuant to Government Code § 4215, if, during the performance of the Work, Contractor discovers utility facilities not identified by City in the Contract Documents, Contractor must immediately provide written notice to City and the utility. City assumes responsibility for the timely removal, relocation, or protection of existing main or trunkline utility facilities located on the Project site if those utilities are not identified in the Contract Documents. Contractor will be compensated in accordance with the provisions of the Contract Documents for the costs of locating, repairing damage not due to Contractor's failure to exercise reasonable care, and removing or relocating utility facilities not indicated in the Plans or Specifications with reasonable accuracy, and for equipment on the Project necessarily idled during such work. Contractor will not be

assessed liquidated damages for delay in completion of the Work, to the extent the delay was caused by City's failure to provide for removal or relocation of the utility facilities.

7.13 Notice of Excavation. Contractor must comply with all applicable requirements in Government Code §§ 4216 through 4216.5, which are incorporated by reference herein. Government Code § 4216.2 requires that, except in an emergency, Contractor must contact the appropriate regional notification center, or Underground Services Alert, at least two working days, but not more than 14 calendar days, before starting any excavation if the excavation will be conducted in an area that is known, or reasonably should be known, to contain subsurface installations. Contractor may not begin excavation until it has obtained and submitted to Engineer an inquiry identification number from Underground Services Alert.

7.14 Trenching and Excavations of Four Feet or More. As required by Public Contract Code § 7104, if the Work includes digging trenches or other excavations that extend deeper than four feet below the surface, the provisions in this Section apply to the Work and the Project.

(A) **Duty to Notify.** Contractor must promptly, and before the following conditions are disturbed, provide written notice to City if Contractor finds any of the following conditions:

(1) Material that Contractor believes may be a hazardous waste, as defined in § 25117 of the Health and Safety Code, that is required to be removed to a Class I, Class II, or Class III disposal site in accordance with the provisions of existing Laws;

(2) Subsurface or latent physical conditions at the Project site differing from those indicated by information about the Project site made available to bidders prior to the deadline for submitting bids; or

(3) Unknown physical conditions at the Project site of any unusual nature, materially different from those ordinarily encountered and generally recognized as inherent in work of the character required by the Contract Documents.

(B) **City Investigation.** City will promptly investigate the conditions and if City finds that the conditions materially differ from those indicated, apparent, or reasonably inferred from information about the Project site made available to bidders, or involve hazardous waste, and cause a decrease or increase in Contractor's cost of, or the time required for, performance of any part of the Work, City will issue a Change Order.

(C) **Disputes.** In the event that a dispute arises between City and Contractor regarding any of the conditions specified in subsection (B) above, or the terms of a Change Order issued by City, Contractor will not be excused from completing the Work within the Contract Time, but must proceed with all Work to be performed under the Contract. Contractor will retain any and all rights provided either by the Contract or by Laws which pertain to the resolution of disputes between Contractor and City.

7.15 Trenching of Five Feet or More. As required by Labor Code § 6705, if the Contract Price exceeds \$25,000 and the Work includes the excavation of any trench or trenches of five feet or more in depth, a detailed plan must be submitted to City for acceptance in advance of the excavation. The detailed plan must show the design of shoring, bracing, sloping, or other provisions to be made for worker protection from the hazard of caving ground during the excavation. If the plan varies from the shoring system standards, it must be prepared by a California registered civil or structural engineer. Use of a shoring,

sloping, or protective system less effective than that required by the Construction Safety Orders is prohibited.

7.16 New Utility Connections. Except as otherwise specified, City will pay connection charges and meter costs for new permanent utilities required by the Contract Documents, if any. Contractor must notify City sufficiently in advance of the time needed to request service from each utility provider so that connections and services are initiated in accordance with the Project schedule.

7.17 Lines and Grades. Contractor is required to use any benchmark provided by the Engineer. Unless otherwise specified in the Contract Documents, Contractor must provide all lines and grades required to execute the Work. Contractor must also provide, preserve, and replace if necessary, all construction stakes required for the Project. All stakes or marks must be set by a California licensed surveyor or a California registered civil engineer. Contractor must notify the Engineer of any discrepancies found between Contractor's staking and grading and information provided by the Contract Documents. Upon completion, all Work must conform to the lines, elevations, and grades shown in the Plans, including any changes directed by a Change Order.

7.18 Historic or Archeological Items.

(A) **Contractor's Obligations.** Contractor must ensure that all persons performing Work at the Project site are required to immediately notify the Project Manager, upon discovery of any potential historic or archeological items, including historic or prehistoric ruins, a burial ground, archaeological or vertebrate paleontological site, including fossilized footprints or other archeological, paleontological or historical feature on the Project site (collectively, "Historic or Archeological Items").

(B) **Discovery; Cessation of Work.** Upon discovery of any potential Historic or Archeological Items, Work must be stopped within an 85-foot radius of the find and may not resume until authorized in writing by City. If required by City, Contractor must assist in protecting or recovering the Historic or Archeological Items, with any such assistance to be compensated as Extra Work on a time and materials basis under Article 6, Contract Modification. At City's discretion, a suspension of Work required due to discovery of Historic or Archeological Items may be treated as Excusable Delay pursuant to Article 5, or as a suspension for convenience under Article 13.

7.19 Environmental Control. Contractor must not pollute any drainage course or its tributary inlets with fuels, oils, bitumens, acids, insecticides, herbicides or other harmful materials. Contractor must prevent the release of any hazardous material or hazardous waste into the soil or groundwater, and prevent the unlawful discharge of pollutants into City's storm drain system and watercourses as required below. Contractor and its Subcontractors must at all times in the performance of the Work comply with all Laws concerning pollution of waterways.

(A) **Stormwater Permit.** Contractor must comply with all applicable conditions of the State Water Resources Control Board National Pollutant Discharge Elimination System General Permit for Waste Discharge Requirements for Discharges of Stormwater Runoff Associated with Construction Activity ("Stormwater Permit").

(B) **Contractor's Obligations.** If required for the Work, a copy of the Stormwater Permit is on file in City's principal administrative offices, and Contractor must comply with it without adjustment of the Contract Price or the Contract Time. Contractor must timely and completely submit required reports and monitoring information required by the conditions of the Stormwater Permit. Contractor also must comply with all other Laws

governing discharge of stormwater, including applicable municipal stormwater management programs.

- 7.20 Noise Control.** Contractor must comply with all applicable noise control Laws. Noise control requirements apply to all equipment used for the Work or related to the Work, including trucks, transit mixers or transient equipment that may or may not be owned by Contractor.
- 7.21 Mined Materials.** Pursuant to the Surface Mining and Reclamation Act of 1975, Public Resources Code § 2710 et seq., any purchase of mined materials, such as construction aggregate, sand, gravel, crushed stone, road base, fill materials, and any other mineral materials must originate from a surface mining operation included on the AB 3098 List, which is available online at:
<ftp://ftp.consrv.ca.gov/pub/omr/AB3098%20List/AB3908List.pdf>.

Article 8 - Payment

- 8.1 Schedule of Values.** Prior to submitting its first application for payment, Contractor must prepare and submit to the Project Manager a schedule of values apportioned to the various divisions and phases of the Work, including mobilization and demobilization. If a Bid Schedule was submitted with Contractor's bid, the amounts in the schedule of values must be consistent with the Bid Schedule. Each line item contained in the schedule of values must be assigned a value such that the total of all items equals the Contract Price. The items must be sufficiently detailed to enable accurate evaluation of the percentage of completion claimed in each application for payment, and the assigned value consistent with any itemized or unit pricing submitted with Contractor's bid.
- (A) **Measurements for Unit Price Work.** Materials and items of Work to be paid for on the basis of unit pricing will be measured according to the methods specified in the Contract Documents.
- (B) **Deleted or Reduced Work.** Contractor will not be compensated for Work that City has deleted or reduced in scope, except for any labor, material or equipment costs for such Work that Contractor reasonably incurred before Contractor learned that the Work could be deleted or reduced. Contractor will only be compensated for those actual, direct and documented costs incurred, and will not be entitled to any mark up for overhead or lost profits.
- 8.2 Progress Payments.** Following the last day of each month, or as otherwise required by the Special Conditions or Specifications, Contractor will submit to the Project Manager a monthly application for payment for Work performed during the preceding month based on the estimated value of the Work performed during that preceding month.
- (A) **Application for Payment.** Each application for payment must be itemized to include labor, materials, and equipment incorporated into the Work, and materials and equipment delivered to the Project site, as well as authorized and approved Change Orders. Each payment application must be supported by the unit prices submitted with Contractor's Bid Schedule and/or schedule of values and any other substantiating data required by the Contract Documents.
- (B) **Payment of Undisputed Amounts.** City will pay the undisputed amount due within 30 days after Contractor has submitted a complete and accurate payment application, subject to Public Contract Code § 20104.50. City will deduct a percentage from each progress payment as retention, as set forth in Section 8.5, below, and may withhold additional amounts as set forth in Section 8.3, below.

8.3 Adjustment of Payment Application. City may adjust or reject the amount requested in a payment application, including application for Final Payment, in whole or in part, if the amount requested is disputed or unsubstantiated. Contractor will be notified in writing of the basis for the modification to the amount requested. City may also deduct or withhold from payment otherwise due based upon any of the circumstances and amounts listed below. Sums withheld from payment otherwise due will be released when the basis for that withholding has been remedied and no longer exists.

(A) For Contractor's unexcused failure to perform the Work as required by the Contract Documents, including correction or completion of punch list items, City may withhold or deduct an amount based on the City's estimated cost to correct or complete the Work.

(B) For loss or damage caused by Contractor or its Subcontractors arising out of or relating to performance of the Work or any failure to protect the Project site, City may deduct an amount based on the estimated cost to repair or replace.

(C) For Contractor's failure to pay its Subcontractors and suppliers when payment is due, City may withhold an amount equal to the total of past due payments and may opt to pay that amount separately via joint check pursuant to Section 8.6(B), Joint Checks.

(D) For Contractor's failure to timely correct rejected, nonconforming, or defective Work, City may withhold or deduct an amount based on the City's estimated cost to correct or complete the Work.

(E) For any unreleased stop notice, City may withhold 125% of the amount claimed.

(F) For Contractor's failure to submit any required schedule or schedule update in the manner and within the time specified in the Contract Documents, City may withhold an amount equal to five percent of the total amount requested until Contractor complies with its schedule submittal obligations.

(G) For Contractor's failure to maintain or submit as-built documents in the manner and within the time specified in the Contract Documents, City may withhold or deduct an amount based on the City's cost to prepare the as-builts.

(H) For Work performed without Shop Drawings that have been accepted by City, when accepted Shop Drawings are required before proceeding with the Work, City may deduct an amount based on the estimated cost to correct unsatisfactory Work or diminution in value.

(I) For fines, payments, or penalties assessed under the Labor Code, City may deduct from payments due to Contractor as required by Laws and as directed by the Division of Labor Standards Enforcement.

(J) For any other costs or charges that may be withheld or deducted from payments to Contractor, as provided in the Contract Documents, including liquidated damages, City may withhold or deduct such amounts from payment otherwise due to Contractor.

8.4 Early Occupancy. Neither City's payment of progress payments nor its partial or full use or occupancy of the Project constitutes acceptance of any part of the Work.

8.5 Retention. City will retain five percent of the full amount due on each progress payment (i.e., the amount due before any withholding or deductions pursuant to Section 8.3, Adjustment of Payment Application), or the percentage stated in the Notice Inviting Bids, whichever is greater, as retention to ensure full and satisfactory performance of the Work.

Contractor is not entitled to any reduction in the rate of withholding at any time, nor to release of any retention before 35 days following City's acceptance of the Project.

(A) **Substitution of Securities.** As provided by Public Contract Code § 22300, Contractor may request in writing that it be allowed, at its sole expense, to substitute securities for the retention withheld by City. Any escrow agreement entered into pursuant to this provision must fully comply with Public Contract Code § 22300 and will be subject to approval as to form by City's legal counsel. If City exercises its right to draw upon such securities in the event of default pursuant to section (7) of the statutory Escrow Agreement for Security Deposits in Lieu of Retention, pursuant to subdivision (f) of Public Contract Code § 22300 ("Escrow Agreement"), and if Contractor disputes that it is in default, its sole remedy is to comply with the dispute resolution procedures in Article 12 and the provisions therein. It is agreed that for purposes of this paragraph, an event of default includes City's rights pursuant to these Contract Documents to withhold or deduct sums from retention, including withholding or deduction for liquidated damages, incomplete or defective Work, stop payment notices, or backcharges. It is further agreed that if any individual authorized to give or receive written notice on behalf of a party pursuant to section (10) of the Escrow Agreement are unavailable to give or receive notice on behalf of that party due to separation from employment, retirement, death, or other circumstances, the successor or delegee of the named individual is deemed to be the individual authorized to give or receive notice pursuant to section (10) of the Escrow Agreement.

(B) **Release of Undisputed Retention.** All undisputed retention, less any amounts that may be assessed as liquidated damages, retained for stop notices, or otherwise withheld pursuant to Section 8.3, Adjustment of Payment Application, will be released as Final Payment to Contractor no sooner than 35 days following recordation of the notice of completion, and no later than 60 days following acceptance of the Project by City's governing body or authorized designee pursuant to Section 11.1(C), Acceptance, or, if the Project has not been accepted, no later than 60 days after the Project is otherwise considered complete pursuant to Public Contract Code § 7107(c).

8.6 Payment to Subcontractors and Suppliers. Each month, Contractor must promptly pay each Subcontractor and supplier the value of the portion of labor, materials, and equipment incorporated into the Work or delivered to the Project site by the Subcontractor or supplier during the preceding month. Such payments must be made in accordance with the requirements of Laws pertaining to such payments, and those of the Contract Documents and applicable subcontract or supplier contract.

(A) **Withholding for Stop Notice.** Pursuant to Civil Code § 9358, City will withhold 125% of the amount claimed by an unreleased stop notice, a portion of which may be retained by City for the costs incurred in handling the stop notice claim, including attorneys' fees and costs, as authorized by law.

(B) **Joint Checks.** City reserves the right, acting in its sole discretion, to issue joint checks made payable to Contractor and a Subcontractor or supplier, if City determines this is necessary to ensure fair and timely payment for a Subcontractor or supplier who has provided services or goods for the Project. As a condition to release of payment by a joint check, the joint check payees may be required to execute a joint check agreement in a form provided or approved by the City Attorney's Office. The joint check payees will be jointly and severally responsible for the allocation and disbursement of funds paid by joint check. Payment by joint check will not be construed to create a contractual relationship between City and a Subcontractor or supplier of any tier beyond the scope of the joint check agreement.

- 8.7 Final Payment.** Contractor's application for Final Payment must comply with the requirements for submitting an application for a progress payment as stated in Section 8.2, above. Corrections to previous progress payments, including adjustments to estimated quantities for unit priced items, may be included in the Final Payment. If Contractor fails to submit a timely application for Final Payment, City reserves the right to unilaterally process and issue Final Payment without an application from Contractor in order to close out the Project. For the purposes of determining the deadline for Claim submission pursuant to Article 12, the date of Final Payment is deemed to be the date that City acts to release undisputed retention as final payment to Contractor, or otherwise provides written notice to Contractor of Final Payment or that no undisputed funds remain available for Final Payment due to offsetting withholdings or deductions pursuant to Section 8.3, Adjustment of Payment Application. If the amount due from Contractor to City exceeds the amount of Final Payment, City retains the right to recover the balance from Contractor or its sureties.
- 8.8 Release of Claims.** City may, at any time, require that payment of the undisputed portion of any progress payment or Final Payment be contingent upon Contractor furnishing City with a written waiver and release of all claims against City arising from or related to the portion of Work covered by those undisputed amounts subject to the limitations of Public Contract Code § 7100. Any disputed amounts may be specifically excluded from the release.
- 8.9 Warranty of Title.** Contractor warrants that title to all work, materials, or equipment incorporated into the Work and included in a request for payment will pass over to City free of any claims, liens, or encumbrances upon payment to Contractor.

Article 9 - Labor Provisions

- 9.1 Discrimination Prohibited.** Discrimination against any prospective or present employee engaged in the Work on grounds of race, color, ancestry, national origin, ethnicity, religion, sex, sexual orientation, age, disability, or marital status is strictly prohibited. Contractor and its Subcontractors are required to comply with all applicable Laws prohibiting discrimination, including the California Fair Employment and Housing Act (Govt. Code § 12900 et seq.), Government Code § 11135, and Labor Code §§ 1735, 1777.5, 1777.6, and 3077.5.
- 9.2 Labor Code Requirements.**
- (A) **Eight Hour Day.** Pursuant to Labor Code § 1810, eight hours of labor constitute a legal day's work under this Contract.
- (B) **Penalty.** Pursuant to Labor Code § 1813, Contractor will forfeit to City as a penalty, the sum of \$25.00 for each day during which a worker employed by Contractor or any Subcontractor is required or permitted to work more than eight hours in any one calendar day or more than 40 hours per calendar week, except if such workers are paid overtime under Labor Code § 1815.
- (C) **Apprentices.** Contractor is responsible for compliance with the requirements governing employment and payment of apprentices, as set forth in Labor Code § 1777.5, which is fully incorporated by reference.
- (D) **Notices.** Pursuant to Labor Code § 1771.4, Contractor is required to post all job site notices prescribed by Laws.

9.3 Prevailing Wages. Each worker performing Work under this Contract that is covered under Labor Code §§ 1720 or 1720.9, including cleanup at the Project site, must be paid at a rate not less than the prevailing wage as defined in §§ 1771 and 1774 of the Labor Code. The prevailing wage rates are on file with the City and available online at <http://www.dir.ca.gov/dlsr>. Contractor must post a copy of the applicable prevailing rates at the Project site.

(A) **Penalties.** Pursuant to Labor Code § 1775, Contractor and any Subcontractor will forfeit to City as a penalty up to \$200.00 for each calendar day, or portion thereof, for each worker paid less than the applicable prevailing wage rate. Contractor must also pay each worker the difference between the applicable prevailing wage rate and the amount actually paid to that worker.

(B) **Federal Requirements.** If this Project is subject to federal prevailing wage requirements in addition to California prevailing wage requirements, Contractor and its Subcontractors are required to pay the higher of the currently applicable state or federal prevailing wage rates.

9.4 Payroll Records. Contractor must comply with the provisions of Labor Code §§ 1771.4, 1776, and 1812 and all implementing regulations, which are fully incorporated by this reference, including requirements for monthly electronic submission of payroll records to the DIR.

(A) **Contractor and Subcontractor Obligations.** Contractor and each Subcontractor must keep accurate payroll records, showing the name, address, social security number, work classification, straight time and overtime hours worked each day and week, and the actual per diem wages paid to each journeyman, apprentice, worker, or other employee employed in connection with the Work. Each payroll record must contain or be verified by a written declaration that it is made under penalty of perjury, stating both of the following:

(1) The information contained in the payroll record is true and correct; and

(2) Contractor or the Subcontractor has complied with the requirements of Labor Code §§ 1771, 1811, and 1815 for any Work performed by its employees on the Project.

(B) **Certified Record.** A certified copy of an employee's payroll record must be made available for inspection or furnished to the employee or his or her authorized representative on request, to City, to the Division of Labor Standards Enforcement, to the Division of Apprenticeship Standards of the DIR, and as further required by the Labor Code.

(C) **Enforcement.** Upon notice of noncompliance with Labor Code § 1776, Contractor or Subcontractor has ten days in which to comply with the requirements of this section. If Contractor or Subcontractor fails to do so within the ten-day period, Contractor or Subcontractor will forfeit a penalty of \$100.00 per day, or portion thereof, for each worker for whom compliance is required, until strict compliance is achieved. Upon request by the Division of Apprenticeship Standards, or the Division of Labor Standards Enforcement, these penalties will be withheld from payments then due to Contractor.

9.5 Labor Compliance. Pursuant to Labor Code § 1771.4, the Contract for this Project is subject to compliance monitoring and enforcement by the DIR.

Article 10 - Safety Provisions

10.1 Safety Precautions and Programs. Contractor and its Subcontractors are fully responsible for safety precautions and programs, and for the safety of persons and property in the performance of the Work. Contractor and its Subcontractors must at all times comply with all applicable health and safety Laws and seek to avoid injury, loss, or damage to persons or property by taking reasonable steps to protect its employees and other persons at any Worksite, materials and equipment stored on or off site, and property at or adjacent to any Worksite.

(A) **Reporting Requirements.** Contractor must immediately notify the City of any death, serious injury or illness resulting from Work on the Project. Contractor must immediately provide a written report to City of each recordable accident or injury occurring at any Worksite within 24 hours of the occurrence. The written report must include: (1) the name and address of the injured or deceased person; (2) the name and address of each employee of Contractor or of any Subcontractor involved in the incident; (3) a detailed description of the incident, including precise location, time, and names and contact information for known witnesses; and (4) a police or first responder report, if applicable. If Contractor is required to file an accident report with a government agency, Contractor will provide a copy of the report to City.

(B) **Legal Compliance.** Contractor's safety program must comply with the applicable legal and regulatory requirements. Contractor must provide City with copies of all notices required by Laws.

(C) **Contractor's Obligations.** Any damage or loss caused by Contractor arising from the Work which is not insured under property insurance must be promptly remedied by Contractor.

(D) **Remedies.** If City determines, in its sole discretion, that any part of the Work or Project site is unsafe, City may, without assuming responsibility for Contractor's safety program, require Contractor or its Subcontractor to cease performance of the Work or to take corrective measures to City's satisfaction. If Contractor fails to promptly take the required corrective measures, City may perform them and deduct the cost from the Contract Price. Contractor agrees it is not entitled to submit a Claim for damages, for an increase in Contract Price, or for a change in Contract Time based on Contractor's compliance with City's request for corrective measures pursuant to this provision.

10.2 Hazardous Materials. Unless otherwise specified in the Contract Documents, this Contract does not include the removal, handling, or disturbance of any asbestos or other Hazardous Materials. If Contractor encounters materials on the Project site that Contractor reasonably believes to be asbestos or other Hazardous Materials, and the asbestos or other Hazardous Materials have not been rendered harmless, Contractor may continue Work in unaffected areas reasonably believed to be safe, but must immediately cease work on the area affected and report the condition to City. No asbestos, asbestos-containing products or other Hazardous Materials may be used in performance of the Work.

10.3 Material Safety. Contractor is solely responsible for complying with § 5194 of Title 8 of the California Code of Regulations, including by providing information to Contractor's employees about any hazardous chemicals to which they may be exposed in the course of the Work. A hazard communication program and other forms of warning and training about such exposure must be used. Contractor must also maintain Safety Data Sheets ("SDS") at the Project site, as required by Laws, for materials or substances used or consumed in the performance of the Work. The SDS will be accessible and available to Contractor's employees, Subcontractors, and City.

(A) **Contractor Obligations.** Contractor is solely responsible for the proper delivery, handling, use, storage, removal, and disposal of all materials brought to the Project site and/or used in the performance of the Work. Contractor must notify the Engineer if a specified product or material cannot be used safely.

(B) **Labeling.** Contractor must ensure proper labeling on any material brought onto the Project site so that any persons working with or in the vicinity of the material may be informed as to the identity of the material, any potential hazards, and requirements for proper handling, protections, and disposal.

10.4 Hazardous Condition. Contractor is solely responsible for determining whether a hazardous condition exists or is created during the course of the Work, involving a risk of bodily harm to any person or risk of damage to any property. If a hazardous condition exists or is created, Contractor must take all precautions necessary to address the condition and ensure that the Work progresses safely under the circumstances. Hazardous conditions may result from, but are not limited to, use of specified materials or equipment, the Work location, the Project site condition, the method of construction, or the way any Work must be performed.

10.5 Emergencies. In an emergency affecting the safety or protection of persons, Work, or property at or adjacent to any Worksite, Contractor must take reasonable and prompt actions to prevent damage, injury, or loss, without prior authorization from the City if, under the circumstances, there is inadequate time to seek prior authorization from the City.

Article 11 - Completion and Warranty Provisions

11.1 Final Completion.

(A) **Final Inspection and Punch List.** When the Work required by this Contract is fully performed, Contractor must provide written notification to City requesting final inspection. The Engineer will schedule the date and time for final inspection, which must include Contractor's primary representative for this Project and its superintendent. Based on that inspection, City will prepare a punch list of any items that are incomplete, missing, defective, incorrectly installed, or otherwise not compliant with the Contract Documents. The punch list to Contractor will specify the time by which all of the punch list items must be completed or corrected. The punch list may include City's estimated cost to complete each punch list item if Contractor fails to do so within the specified time. The omission of any non-compliant item from a punch list will not relieve Contractor from fulfilling all requirements of the Contract Documents. Contractor's failure to complete any punch list item within the time specified in the punch list will not waive or abridge its warranty obligations for any such items that must be completed by the City or by a third party retained by the City due to Contractor's failure to timely complete any such outstanding item.

(B) **Requirements for Final Completion.** Final Completion will be achieved upon completion or correction of all punch list items, as verified by City's further inspection, and upon satisfaction of all other Contract requirements, including any commissioning required under the Contract Documents and submission of all final submittals, including instructions and manuals as required under Section 7.10, and complete, final as-built drawings as required under Section 7.11, all to City's satisfaction.

(C) **Acceptance.** The Project will be considered accepted upon City Council action during a public meeting to accept the Project, unless the Engineer is authorized to accept

the Project, in which case the Project will be considered accepted upon the date of the Engineer's issuance of a written notice of acceptance. In order to avoid delay of Project close out, the City may elect, acting in its sole discretion, to accept the Project as complete subject to exceptions for punch list items that are not completed within the time specified in the punch list.

(D) **Final Payment and Release of Retention.** Final Payment and release of retention, less any sums withheld pursuant to the provisions of the Contract Documents, will not be made sooner than 35 days after recordation of the notice of completion. If Contractor fails to complete all of the punch list items within the specified time, City may withhold up to 150% of City's estimated cost to complete each of the remaining items from Final Payment and may use the withheld retention to pay for the costs to self-perform the outstanding items or to retain a third party to complete any such outstanding punch list item.

11.2 Warranty.

(A) **General.** Contractor warrants that all materials and equipment will be new unless otherwise specified, of good quality, in conformance with the Contract Documents, and free from defective workmanship and materials. Contractor further warrants that the Work will be free from material defects not intrinsic in the design or materials required in the Contract Documents. Contractor warrants that materials or items incorporated into the Work comply with the requirements and standards in the Contract Documents, including compliance with Laws, and that any Hazardous Materials encountered or used were handled as required by Laws. At City's request, Contractor must furnish satisfactory evidence of the quality and type of materials and equipment furnished. Contractor's warranty does not extend to damage caused by normal wear and tear, or improper use or maintenance.

(B) **Warranty Period.** Contractor's warranty must guarantee its Work for a period of one year from the date of Project acceptance (the "Warranty Period"), except when a longer guarantee is provided by a supplier or manufacturer or is required by the Specifications or Special Conditions. Contractor must obtain from its Subcontractors, suppliers and manufacturers any special or extended warranties required by the Contract Documents.

(C) **Warranty Documents.** As a condition precedent to Final Completion, Contractor must supply City with all warranty and guarantee documents relevant to equipment and materials incorporated into the Work and guaranteed by their suppliers or manufacturers.

(D) **Subcontractors.** The warranty obligations in the Contract Documents apply to Work performed by Contractor and its Subcontractors, and Contractor agrees to be co-guarantor of such Work.

(E) **Contractor's Obligations.** Upon written notice from City to Contractor of any defect in the Work discovered during the Warranty Period, Contractor or its responsible Subcontractor must promptly correct the defective Work at its own cost. Contractor's obligation to correct defects discovered during the Warranty Period will continue past the expiration of the Warranty Period as to any defects in Work for which Contractor was notified prior to expiration of the Warranty Period. Work performed during the Warranty Period ("Warranty Work") will be subject to the warranty provisions in this Section 11.2 for a one-year period that begins upon completion of such Warranty Work to City's satisfaction.

(F) **City's Remedies.** If Contractor or its responsible Subcontractor fails to correct defective Work within ten days following notice by City, or sooner if required by the circumstances, City may correct the defects to conform with the Contract Documents at Contractor's sole expense. Contractor must reimburse City for its costs in accordance with subsection (H), below.

(G) **Emergency Repairs.** In cases of emergency where any delay in correcting defective Work could cause harm, loss or damage, City may immediately correct the defects to conform with the Contract Documents at Contractor's sole expense. Contractor or its surety must reimburse City for its costs in accordance with subsection (H), below.

(H) **Reimbursement.** Contractor must reimburse City for its costs to repair under subsections (F) or (G), above, within 30 days following City's submission of a demand for payment pursuant to this provision. If City is required to initiate legal action to compel Contractor's compliance with this provision, and City is the prevailing party in such action, Contractor and its surety are solely responsible for all of City's attorney's fees and legal costs expended to enforce Contractor's warranty obligations herein, in addition to any and all costs City incurs to correct the defective Work.

11.3 Use Prior to Final Completion. City reserves the right to occupy or make use of the Project, or any portions of the Project, prior to Final Completion if City has determined that the Project or portion of it is in a condition suitable for the proposed occupation or use, and that it is in its best interest to occupy or make use of the Project, or any portions of it, prior to Final Completion.

(A) **Non-Waiver.** Occupation or use of the Project, in whole or in part, prior to Final Completion will not operate as acceptance of the Work or any portion of it, nor will it operate as a waiver of any of City's rights or Contractor's duties pursuant to these Contract Documents, and will not affect nor bear on the determination of the time of substantial completion with respect to any statute of repose pertaining to the time for filing an action for construction defect.

(B) **City's Responsibility.** City will be responsible for the cost of maintenance and repairs due to normal wear and tear with respect to those portions of the Project that are being occupied or used before Final Completion. The Contract Price or the Contract Time may be adjusted pursuant to the applicable provisions of these Contract Documents if, and only to the extent that, any occupation or use under this Section actually adds to Contractor's cost or time to complete the Work within the Contract Time.

11.4 Substantial Completion. For purposes of determining "substantial completion" with respect to any statute of repose pertaining to the time for filing an action for construction defect, "substantial completion" is deemed to mean the last date that Contractor or any Subcontractor performs Work on the Project prior to City acceptance of the Project, except for warranty work performed under this Article.

Article 12 - Dispute Resolution

12.1 Claims. This Article applies to and provides the exclusive procedures for any Claim arising from or related to the Contract or performance of the Work.

(A) **Definition.** "Claim" means a separate demand by Contractor, submitted in writing by registered or certified mail with return receipt requested, for a change in the Contract Time, including a time extension or relief from liquidated damages, or a change in the Contract Price, when the demand has previously been submitted to City in accordance with the requirements of the Contract Documents, and which has been

rejected or disputed by City, in whole or in part. A Claim may also include that portion of a unilateral Change Order that is disputed by the Contractor.

(B) **Limitations.** A Claim may only include the portion of a previously rejected demand that remains in dispute between Contractor and City. With the exception of any dispute regarding the amount of money actually paid to Contractor as Final Payment, Contractor is not entitled to submit a Claim demanding a change in the Contract Time or the Contract Price, which has not previously been submitted to City in full compliance with Article 5 and Article 6, and subsequently rejected in whole or in part by City.

(C) **Scope of Article.** This Article is intended to provide the exclusive procedures for submission and resolution of Claims of any amount and applies in addition to the provisions of Public Contract Code § 9204 and § 20104 et seq., which are incorporated by reference herein.

(D) **No Work Delay.** Notwithstanding the submission of a Claim or any other dispute between the parties related to the Project or the Contract Documents, Contractor must perform the Work and may not delay or cease Work pending resolution of a Claim or other dispute, but must continue to diligently prosecute the performance and timely completion of the Work, including the Work pertaining to the Claim or other dispute.

(E) **Informal Resolution.** Contractor will make a good faith effort to informally resolve a dispute before initiating a Claim, preferably by face-to-face meeting between authorized representatives of Contractor and City.

12.2 Claims Submission. The following requirements apply to any Claim subject to this Article:

(A) **Substantiation.** The Claim must be submitted to City in writing, clearly identified as a "Claim" submitted pursuant to this Article 12 and must include all of the documents necessary to substantiate the Claim including the Change Order request that was rejected in whole or in part, and a copy of City's written rejection that is in dispute. The Claim must clearly identify and describe the dispute, including relevant references to applicable portions of the Contract Documents, and a chronology of relevant events. Any Claim for additional payment must include a complete, itemized breakdown of all known or estimated labor, materials, taxes, insurance, and subcontract, or other costs. Substantiating documentation such as payroll records, receipts, invoices, or the like, must be submitted in support of each component of claimed cost. Any Claim for an extension of time or delay costs must be substantiated with a schedule analysis and narrative depicting and explaining claimed time impacts.

(B) **Claim Format and Content.** A Claim must be submitted in the following format:

(1) Provide a cover letter, specifically identifying the submission as a "Claim" submitted under this Article 12 and specifying the requested remedy (e.g., amount of proposed change to Contract Price and/or change to Contract Time).

(2) Provide a summary of each Claim, including underlying facts and the basis for entitlement, and identify each specific demand at issue, including the specific Change Order request (by number and submittal date), and the date of City's rejection of that demand, in whole or in part.

(3) Provide a detailed explanation of each issue in dispute. For multiple issues included within a single Claim or for multiple Claims submitted concurrently, separately number and identify each individual issue or Claim, and include the following for each separate issue or Claim:

- a. A succinct statement of the matter in dispute, including Contractor's position and the basis for that position;
- b. Identify and attach all documents that substantiate the Claim, including relevant provisions of the Contract Documents, RFIs, calculations, and schedule analysis (see subsection (A), Substantiation, above);
- c. A chronology of relevant events; and
- d. Analysis and basis for claimed changes to Contract Price, Contract Time, or any other remedy requested.

(4) Provide a summary of issues and corresponding claimed damages. If, by the time of the Claim submission deadline (below), the precise amount of the requested change in the Contract Price or Contract Time is not yet known, Contractor must provide a good faith estimate, including the basis for that estimate, and must identify the date by which it is anticipated that the Claim will be updated to provide final amounts.

(5) Include the following certification, executed by Contractor's authorized representative:

"The undersigned Contractor certifies under penalty of perjury that its statements and representations in this Claim submittal are true and correct. Contractor warrants that this Claim submittal is comprehensive and complete as to the matters in dispute, and agrees that any costs, expenses, or delay not included herein are deemed waived."

(C) ***Submission Deadlines.***

(1) A Claim disputing rejection of a request for a change in the Contract Time or Contract Price must be submitted within 15 days following the date that City notified Contractor in writing that a request for a change in the Contract Time or Contract Price, duly submitted in compliance with Article 5 and Article 6, has been rejected in whole or in part. A Claim disputing the terms of a unilateral Change Order must be submitted within 15 days following the date of issuance of the unilateral Change Order. These Claim deadlines apply even if Contractor cannot yet quantify the total amount of any requested change in the Contract Time or Contract Price. If the Contractor cannot quantify those amounts, it must submit an estimate of the amounts claimed pending final determination of the requested remedy by Contractor.

(2) With the exception of any dispute regarding the amount of Final Payment, any Claim must be filed on or before the date of Final Payment or will be deemed waived.

(3) A Claim disputing the amount of Final Payment must be submitted within 15 days of the effective date of Final Payment, under Section 8.7, Final Payment.

(4) Strict compliance with these Claim submission deadlines is necessary to ensure that any dispute may be mitigated as soon as possible, and to facilitate cost-efficient administration of the Project. ***Any Claim that is not submitted within the specified deadlines will be deemed waived by Contractor.***

12.3 City's Response. City will respond within 45 days of receipt of the Claim with a written statement identifying which portion(s) of the Claim are disputed, unless the 45-day period is extended by mutual agreement of City and Contractor or as otherwise allowed under Public Contract Code § 9204. However, if City determines that the Claim is not adequately substantiated pursuant to Section 12.2(A), Substantiation, City may first request in writing, within 30 days of receipt of the Claim, any additional documentation supporting the Claim or relating to defenses to the Claim that City may have against the Claim.

(A) **Additional Information.** If additional information is thereafter required, it may be requested and provided upon mutual agreement of City and Contractor. If Contractor's Claim is based on estimated amounts, Contractor has a continuing duty to update its Claim as soon as possible with information on actual amounts in order to facilitate prompt and fair resolution of the Claim.

(B) **Non-Waiver.** Any failure by City to respond within the times specified above will not be construed as acceptance of the Claim, in whole or in part, or as a waiver of any provision of these Contract Documents.

12.4 Meet and Confer. If Contractor disputes City's written response, or City fails to respond within the specified time, within 15 days of receipt of City's response or within 15 days of City's failure to respond within the applicable 45-day time period under Section 12.3, respectively, Contractor may notify City of the dispute in writing sent by registered or certified mail, return receipt requested, and demand an informal conference to meet and confer for settlement of the issues in dispute. If Contractor fails to notify City of the dispute and demand an informal conference to meet and confer in writing within the specified time, Contractor's Claim will be deemed waived.

(A) **Schedule Meet and Confer.** Upon receipt of the demand to meet and confer, City will schedule the meet and confer conference to be held within 30 days, or later if needed to ensure the mutual availability of each of the individuals that each party requires to represent its interests at the meet and confer conference.

(B) **Location for Meet and Confer.** The meet and confer conference will be scheduled at a location at or near City's principal office.

(C) **Written Statement After Meet and Confer.** Within ten working days after the meet and confer has concluded, City will issue a written statement identifying which portion(s) of the Claim remain in dispute, if any.

(D) **Submission to Mediation.** If the Claim or any portion remains in dispute following the meet and confer conference, within ten working days after the City issues the written statement identifying any portion(s) of the Claim remaining in dispute, the Contractor may identify in writing disputed portion(s) of the Claim, which will be submitted for mediation, as set forth below.

12.5 Mediation and Government Code Claims.

(A) **Mediation.** Within ten working days after the City issues the written statement identifying any portion(s) of the Claim remaining in dispute following the meet and confer, City and Contractor will mutually agree to a mediator, as provided under Public Contract Code § 9204. Mediation will be scheduled to ensure the mutual availability of the selected mediator and all of the individuals that each party requires to represent its interests. If there are multiple Claims in dispute, the parties may agree to schedule the mediation to address all outstanding Claims at the same time. The parties will share the costs of the mediator and mediation fees equally, but each party is otherwise solely and separately

responsible for its own costs to prepare for and participate in the mediation, including costs for its legal counsel or any other consultants.

(B) **Government Code Claims.**

(1) Timely presentation of a Government Code Claim is a condition precedent to filing any legal action based on or arising from the Contract. Compliance with the Claim submission requirements in this Article 12 is a condition precedent to filing a Government Code Claim.

(2) The time for filing a Government Code Claim will be tolled from the time Contractor submits its written Claim pursuant to Section 12.2, above, until the time that Claim is denied in whole or in part at the conclusion of the meet and confer process, including any period of time used by the meet and confer process. However, if the Claim is submitted to mediation, the time for filing a Government Code Claim will be tolled until conclusion of the mediation, including any continuations, if the Claim is not fully resolved by mutual agreement of the parties during the mediation or any continuation of the mediation.

- 12.6 Tort Claims.** This Article does not apply to tort claims and nothing in this Article is intended nor will be construed to change the time periods for filing tort-based Government Code Claims.
- 12.7 Arbitration.** It is expressly agreed, under Code of Civil Procedure § 1296, that in any arbitration to resolve a dispute relating to this Contract, the arbitrator's award must be supported by law and substantial evidence.
- 12.8 Burden of Proof and Limitations.** Contractor bears the burden of proving entitlement to and the amount of any claimed damages. Contractor is not entitled to damages calculated on a total cost basis, but must prove actual damages. Contractor is not entitled to speculative, special, or consequential damages, including home office overhead or any form of overhead not directly incurred at the Project site or any other Worksite; lost profits; loss of productivity; lost opportunity to work on other projects; diminished bonding capacity; increased cost of financing for the Project; extended capital costs; non-availability of labor, material or equipment due to delays; or any other indirect loss arising from the Contract. The Eichleay Formula or similar formula will not be used for any recovery under the Contract. The City will not be directly liable to any Subcontractor or supplier.
- 12.9 Legal Proceedings.** In any legal proceeding that involves enforcement of any requirements of the Contract Documents, the finder of fact will receive detailed instructions on the meaning and operation of the Contract Documents, including conditions, limitations of liability, remedies, claim procedures, and other provisions bearing on the defenses and theories of liability. Detailed findings of fact will be requested to verify enforcement of the Contract Documents. All of the City's remedies under the Contract Documents will be construed as cumulative, and not exclusive, and the City reserves all rights to all remedies available under law or equity as to any dispute arising from or relating to the Contract Documents or performance of the Work.
- 12.10 Other Disputes.** The procedures in this Article 12 will apply to any and all disputes or legal actions, in addition to Claims, arising from or related to this Contract, including disputes regarding suspension or early termination of the Contract, unless and only to the extent that compliance with a procedural requirement is expressly and specifically waived by City. Nothing in this Article is intended to delay suspension or termination under Article 13.

Article 13 - Suspension and Termination

13.1 Suspension for Cause. In addition to all other remedies available to City, if Contractor fails to perform or correct Work in accordance with the Contract Documents, including non-compliance with applicable environmental or health and safety Laws, City may immediately order the Work, or any portion of it, suspended until the circumstances giving rise to the suspension have been eliminated to City's satisfaction.

(A) **Notice of Suspension.** Upon receipt of City's written notice to suspend the Work, in whole or in part, except as otherwise specified in the notice of suspension, Contractor and its Subcontractors must promptly stop Work as specified in the notice of suspension; comply with directions for cleaning and securing the Worksite; and protect the completed and in-progress Work and materials. Contractor is solely responsible for any damages or loss resulting from its failure to adequately secure and protect the Project.

(B) **Resumption of Work.** Upon receipt of the City's written notice to resume the suspended Work, in whole or in part, except as otherwise specified in the notice to resume, Contractor and its Subcontractors must promptly re-mobilize and resume the Work as specified; and within ten days from the date of the notice to resume, Contractor must submit a recovery schedule, prepared in accordance with the Contract Documents, showing how Contractor will complete the Work within the Contract Time.

(C) **Failure to Comply.** Contractor will not be entitled to an increase in the Contract Time or Contract Price for a suspension occasioned by Contractor's failure to comply with the Contract Documents.

(D) **No Duty to Suspend.** City's right to suspend the Work will not give rise to a duty to suspend the Work, and City's failure to suspend the Work will not constitute a defense to Contractor's failure to comply with the requirements of the Contract Documents.

13.2 Suspension for Convenience. City reserves the right to suspend, delay, or interrupt the performance of the Work in whole or in part, for a period of time determined to be appropriate for City's convenience. Upon notice by City pursuant to this provision, Contractor must immediately suspend, delay, or interrupt the Work and secure the Project site as directed by City except for taking measures to protect completed or in-progress Work as directed in the suspension notice, and subject to the provisions of Section 13.1(A) and (B), above. If Contractor submits a timely request for a Change Order in compliance with Articles 5 and 6, the Contract Price and the Contract Time will be equitably adjusted by Change Order pursuant to the terms of Articles 5 and 6 to reflect the cost and delay impact occasioned by such suspension for convenience, except to the extent that any such impacts were caused by Contractor's failure to comply with the Contract Documents or the terms of the suspension notice or notice to resume. However, the Contract Time will only be extended if the suspension causes or will cause unavoidable delay in Final Completion. If Contractor disputes the terms of a Change Order issued for such equitable adjustment due to suspension for convenience, its sole recourse is to comply with the Claim procedures in Article 12.

13.3 Termination for Default. City may declare that Contractor is in default of the Contract for a material breach of or inability to fully, promptly, or satisfactorily perform its obligations under the Contract.

(A) **Default.** Events giving rise to a declaration of default include Contractor's refusal or failure to supply sufficient skilled workers, proper materials, or equipment to perform the Work within the Contract Time; Contractor's refusal or failure to make prompt

payment to its employees, Subcontractors, or suppliers or to correct defective Work or damage; Contractor's failure to comply with Laws, or orders of any public agency with jurisdiction over the Project; evidence of Contractor's bankruptcy, insolvency, or lack of financial capacity to complete the Work as required within the Contract Time; suspension, revocation, or expiration and nonrenewal of Contractor's license or DIR registration; dissolution, liquidation, reorganization, or other major change in Contractor's organization, ownership, structure, or existence as a business entity; unauthorized assignment of Contractor's rights or duties under the Contract; or any material breach of the Contract requirements.

(B) **Notice of Default and Opportunity to Cure.** Upon City's declaration that Contractor is in default due to a material breach of the Contract Documents, if City determines that the default is curable, City will afford Contractor the opportunity to cure the default within ten days of City's notice of default, or within a period of time reasonably necessary for such cure, including a shorter period of time if applicable.

(C) **Termination.** If Contractor fails to cure the default or fails to expediently take steps reasonably calculated to cure the default within the time period specified in the notice of default, City may issue written notice to Contractor and its performance bond surety of City's termination of the Contract for default.

(D) **Waiver.** Time being of the essence in the performance of the Work, if Contractor's surety fails to arrange for completion of the Work in accordance with the Performance Bond within seven calendar days from the date of the notice of termination pursuant to paragraph (C), City may immediately make arrangements for the completion of the Work through use of its own forces, by hiring a replacement contractor, or by any other means that City determines advisable under the circumstances. Contractor and its surety will be jointly and severally liable for any additional cost incurred by City to complete the Work following termination, where "additional cost" means all cost in excess of the cost City would have incurred if Contractor had timely completed Work without the default and termination. In addition, City will have the right to immediate possession and use of any materials, supplies, and equipment procured for the Project and located at the Project site or any Worksite on City property for the purposes of completing the remaining Work.

(E) **Compensation.** Within 30 days of receipt of updated as-builts, all warranties, manuals, instructions, or other required documents for Work installed to date, and delivery to City of all equipment and materials for the Project for which Contractor has already been compensated, Contractor will be compensated for the Work satisfactorily performed in compliance with the Contract Documents up to the effective date of the termination pursuant to the terms of Article 8, Payment, subject to City's rights to withhold or deduct sums from payment otherwise due pursuant to Section 8.3, and excluding any costs Contractor incurs as a result of the termination, including any cancellation or restocking charges or fees due to third parties. If Contractor disputes the amount of compensation determined by City, its sole recourse is to comply with the Claim Procedures in Article 12, by submitting a Claim no later than 30 days following notice from City of the total compensation to be paid by City.

(F) **Wrongful Termination.** If Contractor disputes the termination, its sole recourse is to comply with the Claim procedures in Article 12. If a court of competent jurisdiction or an arbitrator later determines that the termination for default was wrongful, the termination will be deemed to be a termination for convenience, and Contractor's damages will be strictly limited to the compensation provided for termination for convenience under Section 13.4, below. Contractor waives any claim for any other damages for wrongful termination including special or consequential damages, lost

opportunity costs, or lost profits, and any award of damages is subject to Section 12.8, Burden of Proof and Limitations.

13.4 Termination for Convenience. City reserves the right, acting in its sole discretion, to terminate all or part of the Contract for convenience upon written notice to Contractor.

(A) **Compensation to Contractor.** In the event of City's termination for convenience, Contractor waives any claim for damages, including for loss of anticipated profits from the Project. The following will constitute full and fair compensation to Contractor, and Contractor will not be entitled to any additional claim or compensation:

(1) *Completed Work.* The value of its Work satisfactorily performed as of the date notice of termination is received, based on Contractor's schedule of values and unpaid costs for items delivered to the Project site that were fabricated for incorporation in the Work;

(2) *Demobilization.* Demobilization costs specified in the schedule of values, or if demobilization costs were not provided in a schedule of values pursuant to Section 8.1, then based on actual, reasonable, and fully documented demobilization costs; and

(3) *Termination Markup.* Five percent of the total value of the Work performed as of the date of notice of termination, including reasonable, actual, and documented costs to comply with the direction in the notice of termination for convenience, and demobilization costs, which is deemed to cover all overhead and profit to date.

(B) **Disputes.** If Contractor disputes the amount of compensation determined by City pursuant to paragraph (A), above, its sole recourse is to comply with the Claim procedures in Article 12, by submitting a Claim no later than 30 days following notice from City of total compensation to be paid by City.

13.5 Actions Upon Termination for Default or Convenience. The following provisions apply to any termination under this Article, whether for default or convenience, and whether in whole or in part.

(A) **General.** Upon termination, City may immediately enter upon and take possession of the Project and the Work and all tools, equipment, appliances, materials, and supplies procured or fabricated for the Project. Contractor will transfer title to and deliver all completed Work and all Work in progress to City.

(B) **Submittals.** Unless otherwise specified in the notice of termination, Contractor must immediately submit to City all designs, drawings, as-built drawings, Project records, contracts with vendors and Subcontractors, manufacturer warranties, manuals, and other such submittals or Work-related documents required under the terms of the Contract Documents, including incomplete documents or drafts.

(C) **Close Out Requirements.** Except as otherwise specified in the notice of termination, Contractor must comply with all of the following:

(1) Immediately stop the Work, except for any Work that must be completed pursuant to the notice of termination and comply with City's instructions for cessation of labor and securing the Project and any other Worksite(s).

(2) Comply with City's instructions to protect the completed Work and materials, using best efforts to minimize further costs.

(3) Contractor must not place further orders or enter into new subcontracts for materials, equipment, services or facilities, except as may be necessary to complete any portion of the Work that is not terminated.

(4) As directed in the notice, Contractor must assign to City or cancel existing subcontracts that relate to performance of the terminated Work, subject to any prior rights, if any, of the surety for Contractor's performance bond, and settle all outstanding liabilities and claims, subject to City's approval.

(5) As directed in the notice, Contractor must use its best efforts to sell any materials, supplies, or equipment intended solely for the terminated Work in a manner and at market rate prices acceptable to City.

(D) **Payment Upon Termination.** Upon completion of all termination obligations, as specified herein and in the notice of termination, Contractor will submit its request for Final Payment, including any amounts due following termination pursuant to this Article 13. Payment will be made in accordance with the provisions of Article 8, based on the portion of the Work satisfactorily completed, including the close out requirements, and consistent with the previously submitted schedule of values and unit pricing, including demobilization costs. Adjustments to Final Payment may include deductions for the cost of materials, supplies, or equipment retained by Contractor; payments received for sale of any such materials, supplies, or equipment, less re-stocking fees charged; and as otherwise specified in Section 8.3, Adjustment of Payment Application.

(E) **Continuing Obligations.** Regardless of any Contract termination, Contractor's obligations for portions of the Work already performed will continue and the provisions of the Contract Documents will remain in effect as to any claim, indemnity obligation, warranties, guarantees, submittals of as-built drawings, instructions, or manuals, record maintenance, or other such rights and obligations arising prior to the termination date.

Article 14 - Miscellaneous Provisions

- 14.1 Assignment of Unfair Business Practice Claims.** Under Public Contract Code § 7103.5, Contractor and its Subcontractors agree to assign to City all rights, title, and interest in and to all causes of action it may have under section 4 of the Clayton Act (15 U.S.C. § 15) or under the Cartwright Act (Chapter 2 (commencing with § 16700) of Part 2 of Division 7 of the Business and Professions Code), arising from purchases of goods, services, or materials pursuant to the Contract or any subcontract. This assignment will be effective at the time City tenders Final Payment to Contractor, without further acknowledgement by the parties.
- 14.2 Provisions Deemed Inserted.** Every provision of law required to be inserted in the Contract Documents is deemed to be inserted, and the Contract Documents will be construed and enforced as though such provision has been included. If it is discovered that through mistake or otherwise that any required provision was not inserted, or not correctly inserted, the Contract Documents will be deemed amended accordingly.
- 14.3 Waiver.** City's waiver of a breach, failure of any condition, or any right or remedy contained in or granted by the provisions of the Contract Documents will not be effective unless it is in writing and signed by City. City's waiver of any breach, failure, right, or remedy will not be deemed a waiver of any other breach, failure, right, or remedy, whether or not similar, nor will any waiver constitute a continuing waiver unless specified in writing by City.

- 14.4 Titles, Headings, and Groupings.** The titles and headings used and the groupings of provisions in the Contract Documents are for convenience only and may not be used in the construction or interpretation of the Contract Documents or relied upon for any other purpose.
- 14.5 Statutory and Regulatory References.** With respect to any amendments to any statutes or regulations referenced in these Contract Documents, the reference is deemed to be the version in effect on the date that bids were due.
- 14.6 Survival.** The provisions that survive termination or expiration of this Contract include Contract Section 11, Notice, and subsections 12.1, 12.2, 12.3, 12.4, 12.5, and 12.6, of Section 12, General Provisions; and the following provisions in these General Conditions: Section 2.2(J), Contractor's Records, Section 2.3(C), Termination, Section 3.7, Ownership, Section 4.2, Indemnity, Article 12, Dispute Resolution, and Section 11.2, Warranty.

END OF GENERAL CONDITIONS

Special Conditions

[Insert Project Special Conditions here, and, if applicable, add any of the optional special conditions provided below.]

Optional Special Conditions

Instructions for Use of Optional Special Conditions:

The following provisions are a limited menu of generic optional provisions for the Special Conditions, each of which may or may not be used, as applicable, in addition to any other Project-specific or City-specific provisions that should be included in the Special Conditions.

A brief explanation of each provision is included in *italics* before the provision itself. The explanation is strictly for internal use and should not be reproduced in the Special Conditions included with the Contract Documents. Only the provision itself should be copied and pasted into the Special Conditions. **Delete the explanations and notes (*in italics*) and any unused provisions.**

Since the ultimate numbering of these provisions will depend on which provisions are selected for use in the Special Conditions, blanks are provided as placeholders for the section numbers in the final document.

The following provision should be completed as indicated, and used to specify the days and times during which the Contractor is permitted to perform the Work. Cross-reference: General Conditions Section 5.2.

___ **Authorized Work Days and Hours.**

___**.1 Authorized Work Days.** Except as expressly authorized in writing by City, Contractor is limited to performing Work on the Project on the following days of the week, excluding holidays observed by City:

< _____ >

___**.2 Authorized Work Hours.** Except as expressly authorized in writing by City, Contractor is limited to performing Work on the Project during the following hours:

< _____ >

The following provision may be used to require a pre-construction conference, and should be adapted for the particular project.

___ **Pre-Construction Conference.** City will designate a date and time for a pre-construction conference with Contractor following Contract execution. Project administration procedures and coordination between City and Contractor will be discussed, and Contractor must present City with the following information or documents at the meeting for City's review and acceptance before the Work commences:

- ___**.1** Name, 24-hour contact information, and qualifications of the proposed on-site superintendent;
 - ___**.2** List of all key Project personnel and their complete contact information, including email addresses and telephone numbers during regular hours and after hours;
 - ___**.3** Staging plans that identify the sequence of the Work, including any phases and alternative sequences or phases, with the goal of minimizing the impacts on residents, businesses and other operations in the Project vicinity;
 - ___**.4** If required, traffic control plans associated with the staging plans that are signed and stamped by a licensed traffic engineer;
 - ___**.5** Draft baseline schedule for the Work as required under Section 5.2, to be finalized within ten days after City issues the Notice to Proceed;
 - ___**.6** Breakdown of lump sum bid items, to be used for determining the value of Work completed for future progress payments to Contractor;
 - ___**.7** Schedule with list of Project submittals that require City review, and list of the proposed material suppliers;
 - ___**.8** Plan for coordination with affected utility owner(s) and compliance with any related permit requirements;
 - ___**.9** Videotape and photographs recording the conditions throughout the pre-construction Project site, showing the existing improvements and current condition of the curbs, gutters, sidewalks, signs, landscaping, streetlights, structures near the Project such as building faces, canopies, shades and fences, and any other features within the Project area limits;
 - ___**.10** If requested by City, Contractor's cash flow projections; and
 - ___**.11** Any other documents specified in the Special Conditions or Notice of Potential Award.
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This optional provision is intended for modifying the default insurance requirements under Section 4.3 of the General Conditions by modifying the CGL limits, waiving the pollution liability insurance, and/or waiving the builder's risk, as indicated in the separate sub-provisions.

___ **Insurance Requirements.** The insurance requirements under Section 4.3 of the General Conditions are modified for this Contract, as set forth below. Except as expressly stated below, all other provisions in Section 4.3 are unchanged and remain in full force and effect.

The following optional sub-provision may be used to adjust the default insurance limits for CGL coverage in Section 4.3 of the General Conditions, subject to prior consultation with and direction from the City's Risk Manager.

___ **Commercial General Liability ("CGL") Insurance.** The CGL insurance policy limits set forth in subsection 4.3(A)(1) of the General Conditions are modified for this Contract to require at least \$<_____> per occurrence and at least \$<_____> general aggregate.

The following optional sub-provision may be used if pollution liability insurance is not necessary for the project. Consult with the City's Risk Manager to confirm whether pollution liability insurance is needed for a project.

___ **Pollution Liability Insurance Waived.** The pollution liability insurance policy requirement set forth in subsection 4.3(A)(4) of the General Conditions is hereby waived and does not apply to this Contract.

The following optional sub-provision should only be used if builder's risk insurance is not applicable, such as for horizontal projects. Consult with the City's Risk Manager to confirm whether builder's risk insurance is required for a project.

___ **Builders Risk Insurance Waived.** The builder's risk insurance policy requirement set forth in subsection 4.3(A)(5) of the General Conditions is hereby waived and does not apply to this Contract.

The following provision may be most useful for longer projects which may extend into the rainy season. As stated, it is intended to supplement Sections 5.2 and 5.3 of the General Conditions. Using reliable data for the Project location, based on normal rainfall patterns over an extended period, e.g., 5-10 years, complete as indicated.

___ **Normal Weather Delay Days.** This provision is intended to supplement the requirements of General Conditions Section 5.2 on Schedule Requirements and Section 5.3 on Delays and Extensions of Contract Time. Based on historic records for the Project location, Contractor's schedule should assume the following number of normal Weather Delay Days for each month:

Month	# Normal Weather Delay Days
January	___

February	—
March	—
April	—
May	—
June	—
July	—
August	—
September	—
October	—
November	—
December	—

Weather Delay Days which do not occur during a given month based on the number of days allocated for that month (above) do not carry over to another month.

The following provision may be used when the Project is to be coordinated by a Construction Manager. The language should be tailored to align with the contract between the City and the Construction Manager, and also to reflect Project-specific procedures and requirements.

___ **Construction Manager Role and Authority.** <_____> is the Construction Manager for this Project. The Construction Manager will assist City in the management of the construction of the Project. The Construction Manager may perform services in the areas of supervision and coordination of the work of Contractor and/or other contractors, scheduling the Work, monitoring the progress of the Work, providing City with evaluations and recommendations concerning the quality of the Work, recommending the approval of progress payments to Contractor, or other services for the Project in accordance with the Construction Manager’s contract with City.

___**.1 Communications.** Contractor must submit all notices and communications relating to the Work directly to the Construction Manager in writing, as follows:

<insert contact information>

With a copy to the Engineer:

<insert contact information>

___**.2 On-Site Management and Communication Procedures.** The Construction Manager will provide and maintain a management team on the Project site to provide contract administration as an agent of City, and will establish and implement coordination and communication procedures among City, the Design Professional, Contractor, and others.

___**.3 Contract Administration Procedures.** The Construction Manager will establish and implement procedures for reviewing and processing requests for clarifications and interpretations of the Contract Documents, Shop Drawings, samples, other submittals, schedule adjustments, Change Order proposals, written proposals for substitutions, payment applications, and maintenance of logs.

___4 **Pre-Construction Conference.** Contractor will attend the pre-construction conference, during which the Construction Manager will review the Contract administration procedures and Project requirements.

___5 **Contractor's Construction Schedule.** The Construction Manager will review Contractor's construction schedules and will verify that each schedule is prepared in accordance with the requirements of the Contract Documents.

*The following should be used for federally funded projects, as applicable. It contains those provisions required under Appendix II to Part 200 of Title 2 of the Code of Federal Regulations (as of 11/10/20) which are not already addressed elsewhere in the Contract Documents. Specific federal funding requirements may vary between federal agencies and may be revised from time to time. **These provisions should be used as needed to comply with applicable federal funding requirements.** Delete provisions that are *not* applicable. Consult the funding agency representative for further information and direction.*

___ **Federally Funded Projects.** This Project is funded in whole or in part by federal funds and subject to the following federal requirements under the terms of the funding agreement(s) between City and the federal agency or agencies providing federal funds, which are fully incorporated by this reference and made part of the Contract Documents. Copies of any funding agreement between City and a funding agency will be made available upon request.

___ **Equal Opportunity.** During the performance of this Contract, the Contractor agrees as follows:

(A) The Contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, sexual orientation, gender identity, or national origin. The Contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment without regard to their race, color, religion, sex, sexual orientation, gender identity, or national origin. Such action will include, but not be limited to the following: Employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this nondiscrimination clause.

(B) The Contractor will, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, sexual orientation, gender identity, or national origin.

(C) The Contractor will not discharge or in any other manner discriminate against any employee or applicant for employment because such employee or applicant has inquired about, discussed, or disclosed the compensation of the employee or applicant or another employee or applicant. This provision will not apply to instances in which an employee who has access to the compensation information of other employees or applicants as a part of such employee's essential job functions discloses the compensation of such other employees or applicants to individuals who do not otherwise have access to such information, unless such disclosure is in response to a formal complaint or charge, in

furtherance of an investigation, proceeding, hearing, or action, including an investigation conducted by the employer, or is consistent with the Contractor's legal duty to furnish information.

(D) The Contractor will send to each labor union or representative of workers with which it has a collective bargaining agreement or other contract or understanding, a notice to be provided advising the labor union or workers' representatives of the Contractor's commitments under this section, and will post copies of the notice in conspicuous places available to employees and applicants for employment.

(E) The Contractor will comply with all provisions of Executive Order 11246 of September 24, 1965, and of the rules, regulations, and relevant orders of the United States Secretary of Labor.

(F) The Contractor will furnish all information and reports required by Executive Order 11246 of September 24, 1965, and by rules, regulations, and orders of the United States Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the administering agency and the United States Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(G) In the event of the Contractor's noncompliance with the nondiscrimination clauses of this contract or with any of the rules, regulations, or orders, this Contract may be canceled, terminated, or suspended in whole or in part and the Contractor may be declared ineligible for further federal government contracts or federally assisted construction contracts in accordance with procedures authorized in Executive Order 11246 of September 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in Executive Order 11246 of September 24, 1965, or by rule, regulation, or order of the United States Secretary of Labor, or as otherwise provided by law.

(H) The Contractor will include the portion of the sentence immediately preceding paragraph (A) and the provisions of paragraphs (A) through (H) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the United States Secretary of Labor issued pursuant to section 204 of Executive Order 11246 of September 24, 1965, so that such provisions will be binding upon each Subcontractor or vendor. The Contractor will take such action with respect to any subcontract or purchase order as the City or funding agency may direct as a means of enforcing such provisions, including sanctions for noncompliance: *Provided*, however, that in the event a Contractor becomes involved in, or is threatened with, litigation with a Subcontractor or vendor as a result of such direction by the City or funding agency, the Contractor may request the United States to enter into such litigation to protect the interests of the United States.

____ **Davis-Bacon Act.** Contractor will pay wages to laborers and mechanics, not less than once a week, and at a rate not less than the current federal prevailing wages specified in the Davis-Bacon Act Wage Determination attached hereto and incorporated herein. By entering into this Contract, Contractor accepts the attached Wage Determination. <The current Davis-Bacon Act Wage Determination, which may be accessed at <https://www.wdol.gov/dba.aspx> must be printed and included with the Contract Documents.>

___ **Copeland “Anti-Kickback” Act.** Contractor will comply with 18 U.S.C. § 874, 40 U.S.C. § 3145, and the requirements of 29 CFR Part 3 as may be applicable, which are incorporated by reference into this Contract. Contractor and Subcontractors must insert this requirement into subcontracts of any tier. Contractor is responsible for compliance with these requirements by each Subcontractor of any tier.

___ **Contract Work Hours and Safety Standards Act.** In addition to the California state law requirements in Article 9 of the General Conditions, Contractor and each Subcontractor must comply with the requirements of the federal Contract Work Hours and Safety Standards Act, as set forth in 40 U.S.C. 3701-3708, as supplemented by the regulations set forth in 29 CFR Part 5, as may be amended from time to time, which are fully incorporated herein, including:

(A) No Contractor or Subcontractor will require or permit any laborer or mechanic performing Work for the Project to work in excess of 40 hours in a work week unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of 40 hours during that work week.

(B) If Contractor or a Subcontractor violates this requirement, the Contractor and any responsible Subcontractor will be liable for the unpaid wages. In addition, the Contractor and Subcontractor will be liable to the United States for liquidated damages. The liquidated damages will be computed with respect to each individual worker as specified under federal law.

(C) Contractor and Subcontractors must insert this requirement into subcontracts of any tier. Contractor is responsible for compliance with these requirements by each Subcontractor of any tier.

___ **Rights to Inventions.** If the federal funding for this Contract meets the definition of “funding agreement” under 37 CFR § 401.2(a) and constitutes an agreement between the City and a small business firm or nonprofit organization regarding the substitution of parties, assignment or performance of experimental, developmental, or research work under that “funding agreement,” the requirements of 37 CFR Part 401, “Rights to Inventions Made by Nonprofit Organizations and Small Business Firms Under Government Grants, Contracts and Cooperative Agreements,” and any implementing regulations issued by the awarding agency, will apply to this Contract and are fully incorporated into the Contract Documents by this reference.

___ **Clean Air Act.** If the Contract is for an amount in excess of \$150,000, Contractor and each Subcontractor must comply with the requirements of the Clean Air Act, as amended, (42 U.S.C. §§ 7401-7671q), which are fully incorporated into the Contract Documents by this reference, including requirements for reporting violations to the awarding agency and the applicable Regional Office for the Environmental Protection Agency. Contractor and Subcontractors must insert this requirement into subcontracts of any tier in excess of \$150,000.

___ **Federal Water Pollution Control Act.** If the Contract is for an amount in excess of \$150,000, the requirements of the Federal Water Pollution Control Act (33 U.S.C. §§ 1251-1387) apply to this Contract and are fully incorporated into the Contract Documents by this reference, including requirements for reporting violations to the awarding agency and the applicable Regional Office for the

Environmental Protection Agency requirements for reporting violations. Contractor and Subcontractors must insert this requirement into subcontracts of any tier in excess of \$150,000.

___ **Suspension and Debarment.** Contractor is required to verify that neither it, nor its principals, as defined at 2 CFR § 180.995, or its affiliates, as defined at 2 CFR § 180.905, are excluded or disqualified, as defined at 2 CFR §§ 180.935 and 180.940. Contractor must comply with 2 CFR Part 180, subpart C and 2 CFR Part 3000, subpart C, and must include a provision requiring compliance with these regulations in any subcontract of any tier. If it is later determined that the Contractor did not comply with the applicable subparts, the Federal Government may pursue available remedies, including, but not limited to, suspension and/or debarment. By submitting a bid and entering into this Contract, Contractor agrees to comply with these requirements.

___ **Byrd Anti-Lobbying Amendment.** If the Contract is for an amount in excess of \$100,000, Contractor must comply with the Byrd Anti-Lobbying Amendment (31 U.S.C. § 1352) and file the certification provided at 44 CFR Part 18, Appendix A, and any disclosures, with the applicable federal agency. Each tier certifies to the tier above that it will not and has not used federal-appropriated funds to pay any person or organization for influencing or attempting to influence an officer or employee of any agency, a member of Congress, officer or employee of Congress, or an employee of a member of Congress in connection with obtaining any federal contract, grant, or any other award covered by 31 U.S.C. § 1352. Each tier will also disclose any lobbying with non-federal funds that takes place in connection with obtaining any federal award. Such disclosures will be forwarded from tier to tier up to the recipient.

___ **Procurement of Recovered Materials.** The requirements of § 6002 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act at 42 U.S.C. § 6962, apply to this Contract and are fully incorporated into the Contract Documents by this reference. For individual purchases of \$10,000 or more, Contractor will make maximum use of products containing recovered materials that are EPA-designated items unless the product cannot be acquired (A) competitively within the Contract schedule, (B) in conformance with Contract performance requirements, or (C) at a reasonable price. Information on this requirement, including a list of EPA-designated items, is available at the EPA's Comprehensive Procurement Guidelines website:
<https://www.epa.gov/smm/comprehensive-procurement-guideline-cpg-program>.

___ **Prohibition on Covered Telecommunications.** Federal loan or grant funds must not be obligated or expended to procure or obtain, extend or renew a contract to procure or obtain, or enter into a contract (or extend or renew a contract) to procure or obtain equipment, services, or systems that use covered telecommunications equipment or services as a substantial or essential component of any system, or as critical technology as part of any system, as further specified in 2 CFR § 200.216, which is fully incorporated into the Contract Documents by this reference. Covered telecommunications equipment or services includes equipment produced by, services provided by, or services using equipment produced by: Huawei Technologies Company or ZTE Corporation (or any subsidiary or affiliate of such entities); Hytera Communications Corporation, Hangzhou Hikvision Digital Technology Company, or Dahua Technology Company (or any subsidiary or affiliate of such entities); or an entity that the Secretary of Defense, in consultation with the Director of the National Intelligence or the Director of the Federal Bureau of Investigation,

reasonably believes to be an entity owned or controlled by, or otherwise connected to, the government of a covered foreign country.

- ___ **Domestic Preferences for Procurements.** As appropriate and to the extent consistent with Laws, the City should, to the greatest extent practicable under a federal award, provide a preference for the purchase, acquisition, or use of goods, products, or materials produced in the United States, as further specified in 2 CFR § 200.322, which is fully incorporated into the Contract Documents by this reference, including, but not limited to, iron, aluminum, steel, cement, and other manufactured products, as specified therein. The requirements of 2 CFR § 200.322 must be included in all subcontracts and purchase orders for work or products under the federal award.

*The following optional provision may be used to attach and incorporate federal contract requirements for projects administered under Caltrans' Local Assistance Procedures Manual ("LAPM"), as specified in Chapter 12 of the LAPM and exhibits thereto, including "Appendix E" to the Standard Title VI/Non-Discrimination Assurances (DOT Order No. 1050.2A), effective September 17, 2020, which may be downloaded from <https://dot.ca.gov/-/media/dot-media/programs/local-assistance/documents/title-vi/appendix-e-of-the-title-v-i-assurances.pdf>. Federal law and LAPM requirements are frequently amended. **DELETE ATTACHMENT B IF NOT APPLICABLE.** Be sure to use the most current version of the LAPM, which may be downloaded from: <https://dot.ca.gov/programs/local-assistance/guidelines-and-procedures/local-assistance-procedures-manual-lapm>.*

- ___ **Federal Contract Requirements.** This Project is funded in whole or in part by federal funds administered under Caltrans' Local Assistance Procedures Manual ("LAPM"). LAPM contract requirements are provided in Attachment B - Federal Contract Requirements. Contractor must comply with the requirements set forth in Attachment B.

The following provision may be used to provide more detail on the Contractor's post-construction restoration requirements. This provision may be adapted by adding Project-Specific requirements or deleting requirements that are not applicable. Cross-reference: General Conditions Section 7.9(E).

- ___ **Close Out Requirements.** Contractor's close out requirements include the following, if applicable:

- ___1 Contractor must replace, with thermoplastic, any existing striping within and adjacent to the Project site that is damaged during the Work. Partially damaged striping must be replaced in its entirety.
- ___2 Contractor must replace any survey monuments that are damaged or removed during the Work, with a Record of Survey filed by a licensed land surveyor as required by California law.
- ___3 Before removing any traffic control or street signs on the Project site, Contractor must take photographs showing their original locations. Upon completion of each phase of construction, Contractor must temporarily reset the signs at those

locations. Contractor must then replace the signs permanently upon completion of the Work and the cost of their removal and replacement must be included in the Bid Proposal.

- ___4 Contractor must maintain any rural mail boxes on the Project site and relocate them to their permanent locations as soon as possible in the course of the Work, to the satisfaction of the affected property owners and the postal service.

The following provision may be used to expressly limit circumstances under which a contractor may be entitled to share in the cost savings from value engineering proposed by the Contractor. Reference Public Contract Code § 7107.

___ **Value Engineering.** The Contractor may be entitled to additional compensation for cost reduction changes made pursuant to a value engineering proposal submitted by the Contractor, subject to the limitations of Public Contract Code § 7107, and in strict compliance with this Section ___. Contractor will not be entitled to any such additional compensation unless all of the following requirements have been met:

- ___1 The Contractor must submit a written proposal for changes to the Plans or Specifications for the Project, in which it:
 - (A) Identifies the written proposal as a proposal for cost reduction changes with reference to this section;
 - (B) Clearly and specifically identifies the proposed cost reduction changes by describing in detail each of the changes proposed with specific references to each of the Specifications and Plans involved in the proposed changes, and providing proposed revised Specifications and Plans as applicable; and
 - (C) Estimates the net amount of the cost reduction and provides the basis for that estimate.
- ___2 The proposed changes have been identified and developed solely by the Contractor, and not, in whole or in part, by the City.
- ___3 The City accepts the proposed changes in whole or in part in a writing signed by the Engineer. The Contractor will only be entitled to additional compensation for those changes specifically accepted by the City. The Engineer will determine the net savings in construction costs from any such changes that are both accepted and implemented by the City. Contractor will not be entitled to more than 50% of the net savings as determined by the Engineer, acting in his or her sole discretion.

END OF SPECIAL CONDITIONS

Attachment A – Federal Bidding Requirements

<insert applicable LAPM requirements or delete Attachment A if not applicable>

END ATTACHMENT A – FEDERAL BIDDING REQUIREMENTS

Attachment B – Federal Contract Requirements

<insert applicable LAPM requirements or delete Attachment B if not applicable>

END ATTACHMENT B – FEDERAL CONTRACT REQUIREMENTS

[Insert Technical Specifications]

[Copy onto City letterhead]

Sent via _____ <insert delivery method, e.g., certified mail or FedEx>

<Date>

<Contractor representative name and title>
<Contractor business name>
<Contractor address>
<Contractor email>

Re: **NOTICE OF POTENTIAL AWARD**
<_____> Project

Dear <Contractor representative name>:

I am pleased to inform you of the intent to recommend that the City Council or its authorized designee award the Contract for the above-referenced Project ("Project") to <_____> ("Contractor") for the Contract Price of \$<_____>, based on Contractor's Bid Proposal submitted on <_____, 20__>.

A copy of the Contract accompanies this Notice. Contractor must execute <___> copies of the enclosed Contract and return the wet-inked copies to my attention, accompanied by the required Payment Bond and Performance Bond, and insurance certificates and endorsements, no later than ten days from the date of this Notice of Potential Award, above.

Failure to execute and return the enclosed Contract and required bonds and insurance documentation within the specified time could result in forfeiture of Contractor's bid security. This Notice of Potential Award does not bind the City to award the Contract. The City, acting through its City Council or authorized designee, reserves the right to reject any or all bids, and the right to decline to award the Contract, notwithstanding any staff recommendation.

Unless expressly authorized or required to engage in any pre-construction activities, such as preparing submittals, Contractor must not commence Work until directed by the Notice to Proceed and will not be entitled to compensation or credit for any Work performed before the date specified in the Notice to Proceed.

Please acknowledge receipt of this Notice of Potential Award by signing the attached Acknowledgement of Notice of Potential Award, as indicated, and transmitting the Acknowledgement to my office via email at: _____ <Email Address>. Do not hesitate to contact me if you have any questions in this regard.

Sincerely,

<Name>
<Title>

Enclosure

Acknowledgement of Notice of Potential Award

On behalf of <_____> ("Contractor"), I acknowledge receipt of the Notice of Potential Award for the <_____> Project:

s/ _____

Name: _____

Title: _____

Date: _____

[Copy onto City letterhead]

Sent via _____ <insert delivery method, e.g., certified mail or FedEx>

<Date>

<Contractor representative name and title>
<Contractor business name>
<Contractor address>
<Contractor email>

Re: **NOTICE TO PROCEED**
<_____> Project

Dear <Contractor representative name>:

By this letter <_____> ("Contractor") is notified to proceed with its Work for the above-referenced Project ("Project"), as required by the Contract Documents. Contractor should start the Work on or before <_____, 20__> ("Start Date"), and must achieve Final Completion within <_____> calendar days from the Start Date.

[Optional: Contractor and its first-tier Subcontractors must attend a mandatory pre-construction conference on <date> at <time> at <address/location>. The following document(s) must be submitted to the Project Manager at _____ <email address>, no later than <_____, 20__>: _____ <list required documents, e.g., baseline schedule, subcontracts, submittal schedule, schedule of values, etc.>]

A copy of the fully executed Contract is enclosed for your files.

Please acknowledge receipt of this Notice to Proceed by signing the attached Acknowledgement of Notice to Proceed, as indicated, and transmitting the Acknowledgement to my office via email at: _____ <Email Address>. Do not hesitate to contact me if you have any questions in this regard.

Sincerely,

<Name>
<Title>

Enclosure

Acknowledgement of Notice to Proceed

On behalf of <_____> ("Contractor"), I acknowledge receipt of the Notice to Proceed for the <_____> Project:

s/ _____

Name: _____

Title: _____

Date: _____

Recording Requested By:
The City of _____

When Recorded Mail To:
_____ <name, title>
_____ <street address>
_____ <city, state and zip>

EXEMPT FROM RECORDING FEES PER
GOVERNMENT CODE § 27383

SPACE ABOVE THIS LINE IS FOR RECORDER'S USE

NOTICE OF COMPLETION
Civil Code §§ 8182, 8184, 9204, and 9208

NOTICE IS HEREBY GIVEN THAT:

1. The undersigned is the agent of the owner of the Project described below.
2. Owner's full name is _____ ("City")
3. City's address is _____
4. The nature of City's interest in the Project is:
___ Fee Ownership ___ Lessee ___ Other: _____
5. Construction work on the Project performed on City's behalf is generally described as follows:
< _____
_____ >.
6. The name of the original Contractor for the Project is: < _____ > located at
< _____ >.
7. The Project was accepted as complete on: < _____, 20__ >.
8. The Project is located at: < _____ >.

Verification: In signing this document, I, the undersigned, declare under penalty of perjury under the laws of the State of California that I have read this notice, and I know and understand the contents of this notice, and that the facts stated in this notice are true and correct.

Date and Place

Signature

Name and Title

*EXEMPT FROM NOTARY ACKNOWLEDGMENT REQUIREMENTS PER
GOVERNMENT CODE § 27287 AND CIVIL CODE § 9208*

SECTION 01 10 00 – SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

- A. This section describes the contract and other work, plus project requirements.
- B. Related Sections:
 - 1. Division 00 – General Conditions.

1.2 CONTRACT DESCRIPTION

- A. Contract: Perform Work of Contract under stipulated sum contract with City per Contract Documents.
- B. Responsible Parties: Construction of the Project is governed by the agreement between the City and the Contractor. Statements in the specifications are directed to this contractor, who has overall responsibility for the subcontractors.
- C. Project Manager: The City will provide a Project Manager who will administer the project during the contract.

1.3 WORK UNDER OTHER CONTRACTS

- A. Separate Contracts: The City may award separate contracts for performance of certain construction operations at the site. Those operations will be conducted simultaneously with the work under the Contract. The Contracts are described in Division 00 Article 2 Section 2.4 – Coordination of Work.

1.4 SCHEDULE OF VALUES

- A. Schedule of Values: The Schedule of Values and Bid Schedule are described in Division 00 Article 8 – Payment. Any bid item may be deleted in total or in part prior to or after award of Contract without compensation in any form or adjustment of other bid items or prices, therefore.

1.5 MISCELLANEOUS WORK

- A. Miscellaneous Work Requirements: Coordinating, handling, transporting, and installing items such as field testing of systems; leveling; furnishing, coordinating, and installing sleeves, anchors, and other embedded items; posting of signs; performing traffic routing work; providing operating and maintenance data and instruction of the City Project Manager; performing warranty work as required; and doing incidental and related work to place all systems and structures in operating condition as designed and as required by Federal, State and Local

codes and regulations. Refer to Division 00 – General Conditions for a summary of work requirements.

1.6 OWNER-FURNISHED PRODUCTS

A. Owner's Responsibilities:

1. Arrange for and deliver Owner-reviewed Shop Drawings, Product Data, and Samples to Contractor.
2. Upon delivery, inspect products jointly with Contractor.
3. Submit claims for transportation damage and replace damaged, defective, or deficient items.
4. Arrange for manufacturers' warranties, inspections, and service.

B. Contractor's Responsibilities:

1. Review Owner-reviewed Shop Drawings, Product Data, and Samples.
2. Receive and unload products at Site; inspect for completeness or damage jointly with Owner.
3. Arrange and pay for delivery to Site. Retrieve items from City Corporation Yard or other designated location, as required, and transport to site. Transport salvaged items to City Corporation Yard.
4. Handle, store, install, and finish products.
5. Repair or replace items damaged after receipt.

1.7 WORK SEQUENCE

- ### A. Stages: Construct Work in stages and at times to accommodate City operation requirements during the construction period; coordinate construction schedule and operations with Project Manager.

1.8 COOPERATION OF CONTRACTOR AND COORDINATION WITH OTHER WORK

- ### A. Coordination: Coordinate with City and any City forces, or other contractors and forces, as required by Division 00 Article 2 Section 2.4 – Coordination of Work.

1.9 CONTRACTOR USE OF PREMISES

- ### A. General: During the construction period the Contractor shall have full use of the premises within the “limits of work” for construction operations, including use of the site. The Contractor's use of the premises is limited only by the City's right to perform work or to retain other contractors on portions of the Project.

B. Use of the Site:

1. Driveways and Entrances: Keep driveways and entrances serving the premises clear and available for emergency vehicles at all times.
2. Traffic and Barrier Plan: When the Contractor needs to access portions of roadways and driveways, on and adjacent to the work, Contractor is

- required to submit a traffic and barrier plan to the City for their review and approval prior to setting up any traffic control devices.
3. **Stored Materials:** The Contractor assumes all responsibility for protection and safekeeping of material stored on the premises. Moving stored materials which interfere with the operations of the City or other contractors is the responsibility of the Contractor.
 4. **Condition of Site:** Maintain work areas in a safe condition at all times, remove all graffiti and accumulated rubbish and surplus materials at the end of each work day, and clean and restore the work site at completion of the work to the condition that existed prior to the start of work.
- C. **Security of the Contractor's Work Area:** The security of the Contractor's work areas and its property, equipment, construction materials, and all other items contained in the Contractor's staging areas or elsewhere on the construction site shall be solely the Contractor's responsibility at all times.

1.10 MAINTENANCE

- A. **Contractor's Responsibility:** Cost of maintenance of systems and equipment prior to Final Acceptance will be considered as included in prices bid and no direct or additional payment will be made therefore.

1.11 OCCUPANCY REQUIREMENTS

- A. **Early Occupancy:** Whenever, in the opinion of Project Manager, Work or any part thereof is in a condition suitable for use, and the best interest of City requires such use, City may take beneficial occupancy of and connect to, open for public use, or use the Work or such part thereof. In such case, City will inspect the Work or part thereof, and issue a Certificate of Substantial Completion for that part of Work.
- B. **Repairs:** Prior to date of Final Acceptance of the Work by City, all necessary repairs or renewals in Work or part thereof so used, not due to ordinary wear and tear, but due to defective materials or workmanship or to operations of Contractor, shall be made at expense of Contractor, as required in Division 00 Article 11 – Completion and Warranty Provisions.
- C. **Acceptance:** Use by City of Work or part thereof as contemplated by this section shall in no case be construed as constituting acceptance of Work or any part thereof. Such use shall neither relieve Contractor of any responsibilities under Contract, nor act as waiver by City of any of the conditions thereof.
- D. **Partial Completion:** City may specify in the Contract Documents that portions of the Work, including electrical and mechanical systems or separate structures, shall be substantially completed on milestone dates prior to substantial completion of all of the Work. Contractor shall notify Project Manager in writing when Contractor considers any such part of the Work ready for its intended use

and substantially complete and request Project Manager to issue a Certificate of Substantial Completion for that part of the Work.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION 01 10 00

SECTION 01 11 00
SUMMARY OF WORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. General description of the Project and the Work to be performed by the Contractor.

1.2 REFERENCED SECTIONS

- A. The following Sections are referenced in this Section
1. Section 09 96 00 – High Performance Coatings
 2. Section 16050 – Electrical Materials and Methods
 3. Section 16940 - Instrumentation
 4. Section 46 61 23 – Gravity Filters

1.3 WORK COVERED BY CONTRACT

- A. The Work covered under this Contract will be performed at the site of the City's Water Treatment Plant (WTP), 300 Olympia Drive, Pittsburg, California 94565. The project location is indicated on the Drawings.
- B. The Work to be performed by the Contractor generally includes:
1. Furnishing all labor, superintendence, materials, power, water, tools, equipment and services required by the Contract Documents or required to complete the Work.
 2. Coordinating the work of all trades.
 3. Furnishing and installing miscellaneous items incidental to or necessary for completion of the Work, whether these items are specifically indicated in the Contract Documents or not.
- C. The Work consists of construction of the following items:
1. Existing Gaseous Chlorine System Modifications
 - a. Changeover from gaseous chlorine to liquid sodium hypochlorite will occur at and/or affect the following unit process / facilities:
 - 1) Chlorine Dioxide Generators: The existing chlorine dioxide generators currently generate chlorine dioxide using two precursor chemicals, gaseous chlorine and liquid sodium chlorite. The generators will be modified to generate chlorine dioxide using three precursor chemicals – liquid sodium hypochlorite, liquid sodium chlorite, and liquid hydrochloric acid.
 - 2) Rapid Mix: The existing rapid mix facility is adjacent to the existing chlorine dioxide contactor. The facility currently applies liquid chlorine dioxide solution to the raw water.
 - 3) Filtered Effluent: The existing combined filter effluent (or treated water) pipeline is injected with chlorine solution just downstream of the existing filters. A new chemical injection location for liquid sodium hypochlorite will be provided along the combined filter effluent pipeline for the new filters.

- b. Remove all existing gaseous chlorine system equipment including, but not limited to: gaseous chlorine one-ton containers, scales, chlorinators, injectors, and supports; chlorine gas piping as shown in the Drawings; chlorine one-ton container monorail and hoist; chlorine gas scrubber and associated mechanical equipment, piping, and ductwork; and other items shown in the Drawings.
 - c. Modify existing chlorine dioxide generators to accommodate change from a two-chemical system (gaseous chlorine and sodium chlorite) to a three-chemical system (sodium hypochlorite, hydrochloric acid, and sodium chlorite), as shown in the Drawings.
2. Bulk Chemical Storage and Metering Improvements
- a. Construct new bulk chemical storage facility for storage and containment of sodium hypochlorite and hydrochloric acid, including concrete structure and metal canopy.
 - b. Apply chemically resistant protective coating system as described in the Specifications
 - c. Furnish and install two (2) new __,000 gallon capacity bulk sodium hypochlorite storage tanks and two (2) new __00 gallon capacity bulk hydrochloric acid storage tanks.
 - d. Furnish and install new chemical, overflow, vent, drain and water piping as shown in the Drawings. Tie into existing water and drain piping as shown in the Drawings.
 - e. Construct new bulk chemical delivery fill station adjacent to the storage facility.
 - f. Furnish new submersible sump pump(s) as shown in the Drawings and described in the Specifications.
 - g. Construct new chemical pipe chase between the new chemical storage facility and the existing chlorine gas room. Furnish and install new chemical system piping in pipe chase. Furnish and install rigid lightweight covers on pipe chase.
 - h. Construct new sodium hypochlorite metering pump pedestals and containment area inside existing gaseous chlorine room.
 - i. Furnish and install four (4) new sodium hypochlorite metering pumps and associated appurtenances as shown in the Drawings.
 - j. Furnish and install new sodium hypochlorite metering pump suction, discharge, and vent piping and appurtenances as shown in the Drawings.
 - k. Furnish and install fiberglass reinforced plastic (FRP) grating over trenches and sumps in and adjacent to the bulk chemical storage facility.
 - l. Furnish and install guardrail and handrail as shown in the Drawings.
3. Filtration Improvements
- a. Temporarily relocate existing 24" Washwater Supply, 36" Settled Water, 24" Washwater Drain and 36" Filter Effluent pipelines, as shown in the Drawings, to facilitate the construction of new filters.
 - b. Design, furnish and install temporary shoring as necessary to facilitate construction of new filters.
 - c. Furnish and install new concrete-encased piping beneath and adjacent to the new filters.
 - d. Construct six (6) filters, common filter gallery, electrical room, and air scour blower room.

- e. Furnish and install new piping, valves, actuators, chemical injection and dispersion equipment, pipe supports, and other mechanical appurtenances inside the filter gallery, as shown in the Drawings.
 - f. Furnish and install new filter underdrains and washwater troughs.
 - g. Construct new settled water manifold and chemical injection facilities upstream of the filters, as shown in the Drawings.
 - h. Connect new 30" Washwater Supply, 36" Settled Water, 36" Washwater Drain and 36" Filter Effluent pipelines to existing 24" Washwater Supply, 36" Settled Water, 24" Washwater Drain and 36" Filter Effluent pipelines as shown in the Drawings.
 - i. Furnish and install new sand filter media, as shown in the Drawings and described in the Specifications.
 - j. Following startup and commissioning of filtration system equipment as described in Section 46 61 23, disinfect new filters and piping as described in the Specifications.
 - k. Furnish and install new granular activated carbon filter media, as shown in the Drawings and described in the Specifications.
 - l. Furnish and install two new air wash supply blowers.
 - m. Conduct acceptance testing of the new filtration system as described in the Specifications.
4. Electrical, Instrumentation, and Control Improvements
- a. Furnish and install all electrical and instrumentation/control conduit, wiring, instruments, switchgear, MCCs, panels, controls, devices, and other items as shown on the E and I drawings and specified in Division 16 of the Contract Documents.
5. Sitework Improvements
- a. Construct grading, paving and drainage facilities, including storm drains, catch basins and manholes, as shown on Drawings.
 - b. Furnish and install all yard piping of various sizes including trenching and backfill, fittings, valves, and appurtenances for filter influent, filter effluent, combined filter effluent, washwater supply, washwater drain, treated water, drains, overflow, potable water (1W), non-potable water (2W), polymer solution, sodium hypochlorite, and liquid ammonium sulfate solution.
 - c. See Sections 16050 and 16940. Furnish and install all electrical and instrumentation conduit, wiring, duct banks, pull boxes, vaults, site lighting, appurtenant details and devices and other items as shown on the E and I Drawings and specified in Division 26 of the Contract Documents.
6. Appurtenant Work
- a. Furnish and install all high-performance coatings and paint as scheduled in Section 09 96 00.
 - b. Furnish and install all additional products, materials, and equipment; and provide all labor, services, construction equipment and other items necessary to complete and make fully functional the project as specified herein, in Contract Documents and shown on the Drawings.

D. Owner-Furnished Equipment (NOT USED)

1.4 OTHER CONTRACTS

- A. The Owner may be undertaking other projects at or in the immediate vicinity of the WTP site simultaneously with the Work to be completed under this project. Coordination with the

contractors undertaking related work or un-related work within the plant is the responsibility of the Contractor.

1.5 SPECIFICATION LANGUAGE

- A. Specifications may be written in the imperative mood in streamlined form in accordance with practices and principals of the Construction Specifications Institute.
- B. Imperative language is directed to the Contractor unless specifically noted otherwise.
- C. The words "shall be" are included by inference where a colon (:) is used within sentences or phrases.

1.6 REGULATORY REQUIREMENTS

- A. Comply with all Federal, State, and local laws, regulations, codes, and ordinance applicable to the work.
- B. References in the Contract Documents to local codes shall mean those of the City of Pittsburgh.
- C. Other standards and codes that apply to the work are designated in the Specifications.

1.7 ACCESS BY GOVERNMENT OFFICIALS

- A. Authorized representatives of governmental agencies shall have access to the work area at all times. Provide proper facilities for access and inspection.
- B. Temporary closure of either the west (lower) or east (upper) plant access roads shall be requested in writing at least 14-days prior to scheduling access road closures. Contractor shall not begin access road closures prior to receipt of authorization by City and shall restore use of closed access road within City-approved duration.

1.8 PROTECTION OF PUBLIC AND PRIVATE PROPERTY

- A. To the greatest extent possible, remove existing features without damaging the materials and re-use the material to place back in the original condition. When existing features are damaged during removal, install new materials of similar type, appearance and function, at no additional cost to the Owner.
- B. Contractor shall be responsible for all damage to streets, roads, driveways, highways, shoulders, ditches, embankments, culverts, bridges, and other public or private property, regardless of location or character, that may be caused by transporting equipment, materials, or workers to or from the work or any part or site thereof, whether by Contractor or Contractor's subcontractors or suppliers.
- C. Keep fire hydrants and water control valves free from obstruction and available for use at all times.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 14 00
WORK SEQUENCE AND CONSTRAINTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Schedule requirements, construction constraints, and a suggested Work sequence for specific elements of the Project.

1.2 REFERENCED SECTIONS

- A. The following Section is reference in this Section
 - 1. Section 01 99 00 – Reference Forms
 - 2. Section 31 50 00 – Excavation Support and Protection

1.3 GENERAL SEQUENCING REQUIREMENTS

- A. The sequencing requirements and construction constraints described are critical elements of the Work and are presented to underscore the importance of proper management, planning, scheduling, coordination, and execution of the Work.
- B. Sequencing requirements and construction constraints have been defined in this Section for only certain structures, facilities, and elements of the Work. All work, whether or not addressed in this Section, shall be governed by applicable specified requirements. If additional shutdown constraints are necessary to allow implementation of Contractor's construction procedures and schedule, the Engineer will establish such constraints.
- C. Contractor's Construction Schedule:
 - 1. Clearly illustrate the proposed sequence of construction.
 - 2. Conform to the sequencing requirements and limitations specified in this Section.
 - 3. Modify or adapt the suggested sequencing as necessary to complete the project provided all environmental and service continuity requirements are met.

1.4 OPERATIONAL CONTINUITY

- A. The City of Pittsburgh owns and operates its water treatment facilities. The Work under this project will interface with these existing facilities.
- B. The existing water treatment plant and distribution system continuously receives raw water, and produces and distributes potable water throughout the City. Do not interrupt functions necessary to maintain operation of these facilities except as approved by the Engineer through review of the Contractor's Facility Outage Plan and as specified herein.
- C. Coordinate the Work to minimize interference and interruption of the normal operation of the Owner's existing facilities through proper planning and by making temporary connections.
- D. Except for allowable out-of-service periods as specified, maintain operation of raw water supply, potable water, chemicals, sanitary and storm sewers, service laterals, catch basins, manholes, and similar facilities as well as chemical deliveries.
 - 1. Provide temporary pumps, piping, power, bulkheads, plugs, and other devices that are required to keep such facilities in operation when these must be temporarily taken out of service in order to conduct the Work.

2. Notify the Engineer in writing 7 days in advance of the time it is necessary to take utilities out of service.
3. Notify public agencies and utility companies when service to customers will be temporarily interrupted to perform the Work and coordinate shutdowns with these agencies.

1.5 ACCESS

- A. The existing facility where Contractor's work is to be done will be occupied by the Owner throughout the construction period. Access to the site by the Owner's personnel is required for daily operations, maintenance, and administration. Additionally, regular traffic into and out of the site is to be expected.
- B. Contractor shall provide all necessary access to the Owner's personnel as required to safely and efficiently operate/maintain the facilities. At all times during the Contract duration, the Contractor is to provide the Owner's personnel and representatives safe and immediate access to all process control equipment.
- C. Contractor shall provide for unimpeded access for all delivery vehicles transporting materials, chemicals and equipment to the facility for the Owner's operations. Contractor shall coordinate the work to avoid interference with vehicular access to the existing plant site and normal operation of plant equipment and processes.

1.6 WORK AFFECTING PRIVATE PROPERTY (NOT USED)

1.7 FACILITY OUTAGE PLAN

- A. Prepare and submit a detailed Facility Outage Plan when removal of an existing system or facility from service is necessary to complete the Work.
- B. A System Outage Request (SOR) form shall accompany each outage or bypass plan (See Section 01 99 00). Coordinate the outage schedule with the overall construction schedule.
- C. Submit the Facility Outage Plan to the Engineer for review and approval at least 4 weeks prior to the scheduled outage. Develop the Facility Outage Plan to satisfy the Work Sequence restrictions and conditions specified in this Section. Do not proceed with any Work involving facility outages until the Outage Plan has been approved by the Engineer.
- D. Attend a meeting with the Construction Manager and Owner one (1) week before the scheduled outage to review the SOR. Any changes to the SOR must be approved by the Construction Manager and the Owner prior to the outage. Significant changes shall, at the sole discretion of the Owner, cause the scheduled outage to be rescheduled for the nearest date acceptable to the Owner.
- E. The Facility Outage Plan shall describe, as applicable, a listing of existing facilities that will be taken out of service, methods for preventing bypassing of other treatment units, the length of time required to complete the operation, and the necessary personnel and equipment which will be provided in order to successfully complete the operation. At the sole discretion of the Owner, the Contractor shall provide up to double the amount of materials and equipment described by the Facility Outage Plan.
- F. The Facility Outage Plan shall describe the Contractor's contingency plan that shall be initiated in the event that its temporary facilities fail or it becomes apparent that the time constraints described in the approved SOR cannot be met. The contingency plan shall conform to all specified outage requirements.

1.8 REMOVING EXISTING FACILITIES FROM SERVICE

- A. Existing systems or individual equipment items shall be isolated, decommissioned, de-energized, or depressurized only by the Owner's operations personnel. This work will be done in accordance with the Facility Outage Plan and schedule prepared by the Contractor.
- B. The Contractor shall design and provide all necessary bulkheads, shoring, and support structures to allow isolation of work areas from roads, structures, vaults, tanks, pipes, and/or channels that are in service. Bulkheads, shoring, and support structures shall conform to applicable OSHA and Cal-OSHA requirements.
- C. The Contractor shall provide all necessary temporary pumps, piping, power, electrical wiring, controls, and labor during and subsequent to all shutdown activities as required. Maintain adequate access to the plant facilities, utilities, and equipment during construction to allow continued safe operation and maintenance by Owner's personnel to take place.
- D. Prior to any shutdown or flow diversion, all materials, bypass pumps, fittings, supports, equipment and tools shall be on the site and all necessary skilled labor scheduled prior to starting any connection work.
- E. If valves or gates need to be opened or closed, or mechanical equipment turned off or turned on, or similar operations performed to allow construction to proceed, this is to be performed by the Owner's operations staff working in coordination with Contractor personnel. Valves and gates that may be used to isolate pipelines, tanks, basins, clearwells, and other facilities may not completely seal. Contractor shall allow for leakage in planning the Work. Contractor shall clean and disinfect the work areas as required to perform the work and prior to returning equipment and other facilities to operational status.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 WORK COORDINATION

- A. Schedule and coordinate the overall Work and construction operations, including the work of subcontractors and the timely provision of products and supplies.
- B. Perform Work in an orderly and logical sequence. Individual specification Sections may identify specific requirements that are related to Work sequence. These types of constraints are not repeated in this Section but shall be followed by the Contractor.

3.2 WORK CONSTRAINTS

- A. General Requirements
 - 1. Connections to the existing treatment plant facilities, including piping, electrical and/or control connections must be coordinated with the operation of the existing treatment plant. The following sub-sections are intended to describe the constraints and sequencing associated with these connections.
 - 2. Contractor is required to identify all work constraints and sequencing of all connections to the existing water treatment plant facilities and submit a complete and detailed Work Sequencing Plan, including a schedule of proposed dates involved, to the Construction Manager within sixty (60) calendar days after Notice to Proceed is issued by the Owner. The schedule of dates should be consistent with the Contractor's CPM Baseline Schedule and all subsequent CPM schedule updates. cpm

B. Work Hours

1. Except as otherwise required for the safety or protection of persons and except as otherwise stated in the Contract Documents, Work may only be performed Monday through Friday during the hours of 7:00 am and 5:00 pm. Contractor will not perform Work on a Sunday or any legal holiday defined by the City of Pittsburg without written consent from the Owner.
2. Legal holidays are defined as:
 - a. Monday, January 2, 2023 (New Years Day observed)
 - b. Monday, January 16, 2023 (Dr. Martin Luther King, Jr. Day)
 - c. Monday, February 20, 2023 (President's Day)
 - d. Monday, May 29, 2023 (Memorial Day)
 - e. Monday, June 19, 2023 (Juneteenth)
 - f. Tuesday, July 4, 2023 (Independence Day)
 - g. Monday, September 4, 2023 (Labor Day)
 - h. Friday, November 10, 2023 (Veterans Day observed)
 - i. Thursday, November 23, 2023 and Friday, November 24, 2023 (Thanksgiving Holiday)
 - j. Monday, December 25, 2023 (Christmas Day)
 - k. When a holiday falls on Sunday, the following Monday is recognized as the legal holiday. When a holiday falls on a Saturday, the preceding Friday is recognized as the legal holiday.

C. Contractor shall undertake the Work in compliance with the constraints defined in the following paragraphs:

1. The flow of raw water shall not be stopped or otherwise diverted from the WTP at any time.
2. At least three (3) pre-treatment basins must remain in service at all times. Additional constraints related to the operation of the pre-treatment basins are as follows:
 - a. [TBD]
 - b. [TBD]
 - c. [TBD]
3. All eight (8) of the existing filters must remain in service at all times prior to successful commissioning, startup, and demonstration of the new filters. Additional constraints related to the operation of the existing filters are as follows:
 - a. [TBD]
 - b. [TBD]
 - c. [TBD]
4. The existing chlorine gas system shall remain in service at all times prior to successful commissioning, startup, and demonstration of the sodium hypochlorite and hydrochloric acid storage systems, and the temporary sodium hypochlorite metering system. Additional constraints related to the operation of the existing chlorine system are as follows:
 - a. [TBD]
 - b. [TBD]
 - c. [TBD]

5. Temporary bypass piping as described in the plans must remain in service for the duration of the filter building construction. Additional constraints related to temporary bypass piping are as follows:
 - a. Any required shutdowns for connection to existing pipes for temporary relocation shall be coordinated with plant staff as described in Paragraph 1.4.D.2.
 - b. [TBD]
6. Modifications to the water treatment plant's internal site access roads
 - a. [For Kelsey]
7. Construction of the new filters shall not commence until the Owner has reviewed and accepted the Contractor's shoring system design, as developed in accordance with Section 31 50 00.

3.3 SUGGESTED WORK SEQUENCE

- A. The following work sequence is one suggested means of constructing the project, and shall be followed in general unless another suitable method of completing the work is developed by the Contractor and approved by the Owner. The work sequence is arranged sequentially, and follows processes and related facilities within the plant (i.e., from "upstream" to "downstream" processes), rather than by work item; suggested sequencing of work items is discussed, where applicable, under each process or facility heading. This suggested work sequence is general in nature and does not include all work activities required by this Contract for completion of the work, but is intended to describe important events necessary to minimize disruption of the existing facilities and to ensure compliance with potable water supply operating permit requirements. The suggested work sequence shall be coordinated with the requirements of other specification Sections and the Drawings in order to complete the Work in a timely and satisfactory manner.
- B. Suggested Work Sequence
 1. Bulk Chemical Storage and Metering Improvements
 - a. Construction and testing of the bulk chemical storage improvements, as well as installation and testing of the temporary sodium hypochlorite metering facility, must be completed prior to beginning demolition and modifications of the existing gaseous chlorine system.
 - b. Filling of the new chemical storage tanks with chemical must also be completed prior to startup of the new bulk chemical storage improvements and temporary sodium hypochlorite metering facility.
 - c. The new bulk chemical storage area must be coated with a chemically resistant coating system and the emergency eyewash and shower units must be operational prior to placing the new storage tanks into service.
 - d. Construction and testing of the permanent sodium hypochlorite metering facility cannot begin until demolition of the existing gaseous chlorine system equipment has been completed.
 2. Existing Gaseous Chlorine System Modifications
 - a. Demolition and modifications of existing the gaseous chlorine system cannot begin until construction and testing of the bulk chemical storage improvements, as well as installation and testing of the temporary sodium hypochlorite metering facility, has been completed.
 3. Filtration Improvements
 - a. Construction of the new filters cannot begin until the following has been completed:

- 1) The affected existing yard piping and conduits in the vicinity of the new filters have been relocated as shown in the Drawings.
 - a) Refer to the pipe relocation and installation sequencing Drawings for the suggested work sequence for affected yard piping and conduits.
 - 2) The existing lower access road has been relocated as shown in the Drawings.
 - 3) The Contractor has coordinated with the Owner regarding access requirements for bulk chemical delivery trucks and other periodic visitors to the WTP.
- b. Upon construction of the new structure(s) for the filters, filter gallery, blower room, and electrical room, relocation of temporary bypass pipelines and construction of new pipelines will include, but may not be limited to, the following:
- 1) 24" SD
 - 2) 30" RW
 - 3) 36" SW
 - 4) 24" WWS
 - 5) 8" TKS
 - 6) 4" NG
 - 7) 36" CFE
 - 8) 36" WWD
- c. New filter basins must undergo successful hydraulic structure testing prior to undergoing disinfection.
- d. All filter systems, including blowers, conveyance equipment, valves, instruments, and controls, must undergo successful commissioning prior to disinfecting the new filters.
- e. New filters must successfully complete disinfection and post-disinfection bacteriological testing prior to placing granular activated carbon (GAC) media.
4. Electrical, Instrumentation, and Control Improvements
- a. Bulk Chemical Storage and Metering Improvements
- 1) Provide and commission instrumentation and control for the temporary sodium hypochlorite metering facility installed along with the installation of the bulk storage improvements.
 - a) This includes temporary modifications of the existing control system to provide flow pacing signals and status and alarm monitoring for the temporary equipment.
 - 2) Upon demolition of the existing gaseous chlorine system, the new permanent controls shall be installed as part of the permanent metering facility. This includes installation of CECP2 and integration with MCP (existing) and the plant SCADA system.
 - 3) Cutover from the temporary system to the permanent metering facilities shall be performed after successful commissioning of the permanent metering facility.
 - 4) Remove the temporary chemical systems and associated temporary control system modifications.
 - 5) After successful commissioning of the permanent chemical systems and metering facilities, disconnect any electrical loads related to temporary systems as shown on Drawings.

- b. Existing Gaseous Chlorine System Modifications
 - 1) Once the gaseous chlorine system is decommissioned:
 - a) Remove associated field instrumentation and control equipment as well as related control application programming from MCP and the SCADA human machine interface (HMI).
 - b) Disconnect electrical loads related to gaseous chlorine system as shown on Drawings.
- c. Filtration Improvements
 - 1) Install instrumentation, networking and control panels in conjunction with the construction of the new filters, filter gallery, blower room, and electrical room.
 - 2) Coordinate plant shutdowns with the Owner to integrate the new control panels into the plant network and SCADA system.
 - 3) Integrate vendor provided equipment such as the blowers into the filter control system.
 - 4) Provide temporary control of the backwash supply water during commissioning to coexist with the existing filters.
 - 5) Commission the new filters and associated equipment.
 - 6) Once successfully commissioned, continue with disinfecting the new filters and preparations for putting them into service.
 - 7) Migrate the existing filter backwash supply control to the new filter control panel.
 - 8) Existing filter electrical loads shall only be disconnected after new filter system is installed and fully operational.
 - 9) Once the new filters are in service and the existing filters have been decommissioned, remove logical connection configurations to existing filter control panels and any associated control logic from MCP.
- 5. Sitework Improvements
 - a. Completion of new structures (e.g., new bulk chemical storage facilities and new filters), along with appurtenance buried pipelines, must be completed prior completing grading, drainage and paving improvements.
- 6. Appurtenant Work
 - a. Anything to include here?

END OF SECTION

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SECTION 01 22 00 –UNIT PRICES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section specifies procedures and requirements for measurement and payment for unit price items listed on the Bid Form for each unit of work described herein.
- B. Refer to the Instruction to Bidders and Division 00 General Conditions and Division 00 Article 8 – Payment for related requirements pertaining to change orders, payments and unit prices.
- C. Prices:
 - 1. In addition to Base Bid, Bidder shall quote unit prices, in appropriate spaces on Bid Form for each unit of work as described herein. Change Orders will be based on unit prices quoted on Bid Form for applicable work.
 - 2. In event any unit price quoted appears to compare unfavorably with currently established prices for type of work, City reserves the right to require quoted price to be substantiated or adjusted prior to execution of contract.
 - 3. Unit prices listed on the Bid Form for the following items shall constitute full and complete compensation for each unit, and shall include cost of temporary and administrative work, permits, bonds, insurance, sales taxes, overhead, profit and every other expense, direct or indirect, incident to accomplishment of work under each item.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 MEASUREMENT

- A. Measurement of quantities for payment will be made or determined by City's Inspector.
 - 1. Volume of any material shall be based on information included with Drawings and additional measurements obtained by Inspector, or by combination of such information, or in a manner which, in the opinion of the Inspector, is best suited to obtain necessary accuracy.

2. In case of unit prices based upon weight measurement, certified weight tickets shall be supplied at time of delivery of materials.
3. Excess materials delivered to the site, but not incorporated in the work, will not be paid for.

3.2 UNIT PRICE ITEMS

** To be edited for specific project and connected with bid items in Special Conditions **

Example:

A. Aggregate Base Course:

1. Basis of Measurement: By the cubic yard or tons as specified in the bid form. If measurement is by the ton, water content in excess of optimum moisture content shall be deducted from the total weight of aggregate. If measurement is by the cubic yard, quantities of aggregates will be calculated on the basis of dimensions shown on the plans. No allowance will be made for aggregate rejected or placed outside said dimensions unless otherwise order by the City's Project Manager. Aggregate Base used under concrete work such as curb and gutter, valley gutter, sidewalk, driveways, curb ramps, median curbs, median nose surfacing, bus turnouts, retaining curbs, and in utility trenches shall not be measured.
2. Basis of Payment: Includes full compensation for furnishing all labor, materials, tools, equipment and incidentals, in aggregate base supplying fill material, stockpiling, scarifying subgrade surface, placing where required, watering, dust palliative, leveling, compacting and certifying the top of aggregate base design grades.
3. Aggregate Base used under concrete work such as curb and gutter, valley gutter, sidewalk, retaining curbs, etc. shall considered incidental to the item most closely related to and no separate compensation will be allowed therefor. Aggregate base used in utility trenches shall be considered incidental to the cost per linear foot paid for the utility pipes as shown on the bid form and no separate compensation will be allowed therefor.

3.3 PAYMENT

- A. Payment will be made for actual quantity of work performed at contract unit price, as directed and accepted, in accordance with requirements of the General Conditions.

END OF SECTION 01 22 00

SECTION 01 23 00 – ALTERNATES**PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes administrative and procedural requirements governing Alternates. Each Alternate is identified by number and describes the basic changes to be made in the Work.
- B. Definition: An alternate is an amount proposed by bidders and stated on the Bid Form for work defined in the Bidding Requirements that the City may elect to add to or deduct from the Base Bid amount, if the City decides to accept a corresponding change in either the amount of construction to be completed, or in the products, materials, equipment, systems, or installation methods described in the Contract Documents. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate the Alternate into the Work. No other adjustments are made to the Contract Sum.
- C. Related Requirements:
 - 1. Instruction to Bidders
 - 2. Materials and Methods Required by Alternates: Pertinent Specification Sections.

1.2 ALTERNATE BIDS

- A. Alternates will be accepted at option of the City; the Base Bid, including additive or deductive Alternates accepted by the City, will be an element considered in the award of the Contract.

1.3 SCHEDULE OF ALTERNATES

Examples Add Alternate No. x - [Name of Alternate]: Add [item described here]

- B. Deduct Alternate No. x - [Name of Alternate]: Delete [item] specified in Section[s] [_____], shown on Drawing[s] [_____].
- C. Replace Alternate No. x - [Name of Alternate]: Delete [item] specified in Section[s] [_____], shown on Drawing[s] [_____]; replace with [item] specified in Section[s] [_____], shown on Drawing[s] [_____].

PART 2 - EXECUTION

2.1 MODIFICATIONS TO WORK

- A. Execute accepted alternates under the same conditions as other Work of this Contract.
- B. Immediately following the award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate whether alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated modifications to alternates.
- C. Modify or adjust affected adjacent Work as required to completely and fully integrate that Work into the Project.

END OF SECTION 01 23 00

SECTION 01 25 00 – SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for handling requests for substitutions made after award of the Contract.
- B. Related Sections:
 - 1. [Notice Inviting Bidders](#)
 - 2. [Instructions to Bidders](#)
 - 3. [Division 00 – General Conditions Article 7.](#)

1.2 DEFINITIONS

- A. Definitions in this Article do not change or modify the meaning of other terms used in the Contract Documents.
- B. Substitutions: Changes in products, materials, equipment, and methods of construction required by the Contract Documents proposed by the Contractor after award of the Contract are considered to be requests for substitutions.
 - 1. Substitutions will not be considered during the Bid process.
 - 2. The following are not considered to be requests for substitution:
 - a. Revisions to the Contract Documents requested by the Owner or Architect/Engineer.
 - b. Specified options of products and construction methods included in the Contract Documents.
 - 3. The following are considered to be requests for substitution:
 - a. Any manufacturer, product, process, or method identified in the Special Conditions, specifications or on the Drawings as either “or equal” or “equal products of another manufacturer when approved in advance by the Architect/Engineer per this Section 01 25 00 – Substitution Procedures”.

1.3 SUBMITTALS

- A. Request for Substitution (RFS) Submittal:
 - 1. Receipt:
 - a. The Architect/Engineer will consider requests for substitution (RFS) if received within thirty-five (35) calendar days after the Notice to Proceed.
 - b. Requests received after thirty-five (35) calendar days after the Notice to Proceed may be considered or rejected at the discretion of the Project Manager and/or Architect/Engineer.

1. Submit three (3) copies of each request for substitution for consideration. Submit requests in the form and according to the procedures required in [Division 00 – General Conditions](#).
2. Identify the product or the fabrication or installation method to be replaced in each request. Include related Special Conditions, Specification Section and Drawing numbers.
3. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:
 - a. Coordination information, including a list of change or modifications needed to other parts of the Work and to construction performed by the Owner and separate contractors that will be necessary to accommodate the proposed substitution.
 - b. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements, such as performance, weight, size, durability, operations, maintenance, and visual effect.
 - c. Product Data, including Drawings and descriptions of products and fabrication and installation procedures.
 - d. Samples, where applicable or requested.
 - e. A statement indicating the substitution's effect on the Contractor's Construction Schedule compared to the schedule without the approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.
 - f. Cost information, including a proposal of net change, if any, in the Contract Sum.
 - g. The Contractor's certification that the proposed substitution conforms to the requirements in the Contract Documents, in every respect and is appropriate for the applications indicated.
 - h. The Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of the failure of the substitution to perform adequately.
4. Architect/Engineer Action: If necessary, the Architect/Engineer will request additional information or documentation for evaluation within fourteen (14) calendar days of receipt of a request for substitution. The Project Manager will route to the Contractor, the Architect/Engineer's acceptance or rejection of the substitution within fourteen (14) days of the receipt of the request, or receipt of addition information or documentation.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

- A. Conditions: The Architect/Engineer will receive and consider the Contractor's request for substitution when one or more of the following conditions are satisfied, as determined by the Architect/Engineer. If the following conditions are not

satisfied, the Architect/Engineer will return the requests without action except to record non-compliance with these requirements:

1. Extensive revisions to the Contract Documents are not required.
 2. Proposed changes are in keeping with the general intent of the Contract Documents.
 3. The request is timely, fully documented, and properly submitted.
 4. The request is directly related to an "or-equal" clause or similar language in the Contract Documents.
 5. The requested substitution offers the Owner a substantial advantage, in cost, time, energy conservation, maintainability, or other considerations, after deducting additional responsibilities the Owner must assume. The Owner's additional responsibilities may include compensation to the Architect/Engineer for redesign and evaluation services, compensation to the Project Manager for additional management and coordination, increased cost of other construction by the Owner, and similar considerations.
 6. The specified product or method of construction cannot be provided in a manner that is compatible with other materials and where the Contractor certifies that the substitution will overcome the incompatibility.
 7. The specified product or method of construction cannot be coordinated with other materials and where the Contractor certifies that the proposed substitution can be coordinated.
 8. The specified product or method of construction cannot provide a warranty required by the Contract Documents and where the Contractor certifies that the proposed substitution provides the required warranty.
- B. The Contractor's submittal and the Architect/Engineer acceptance of Shop Drawings, Product Data, or Samples for construction activities not complying with the Contract Documents do not constitute an acceptable or valid request for substitution, nor do they constitute approval.

PART 3 - EXECUTION

NOT USED

END OF SECTION 01 25 00

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SECTION 01 26 00 – CONTRACT MODIFICATION PROCEDURES**PART 1 - GENERAL**

1.1 SUMMARY

- A. This section describes general procedural requirements for alterations, modifications and extras.
- B. Related Sections:
 - 1. [Division 00 General Conditions, Articles 5, 6, and 8](#)
 - 2. [Section 01 29 00 – Payment Procedures](#)

1.2 GENERAL

- A. Any change in scope of work or deviation from Drawings, Special Conditions, or Specifications shall be accomplished only when authorized in writing by Project Manager.
- B. Changes in scope of Work or deviation from Drawings, Special Conditions, or Specifications may be initiated only by Contractor or Project Manager.
 - 1. Contractor may initiate changes by submitting Requests for Interpretation (RFI), Requests for Substitution (RFS), Notice of Concealed or Unknown Conditions, or Notice of Hazardous Waste Conditions.
 - a. RFIs shall be submitted to seek clarification of Contract Documents in accordance with [Section 01 26 13 – Requests for Interpretation](#).
 - b. RFSs shall be submitted in accordance with [Section 01 25 00 – Substitution Procedures](#) to request substitution of materials or methods of execution.
 - c. Notices of Concealed or Unknown Conditions shall be submitted in accordance with [Division 00 - General Conditions](#).
 - d. Notices of Hazardous Waste Conditions shall be submitted in accordance with [Division 00 - General Conditions](#).
 - 2. Contractor shall be responsible for its costs to implement and administer RFIs and RFSs throughout the Contract duration. Regardless of the number of RFIs submitted, Contractor will not be entitled to additional compensation. Contractor shall be responsible for both City's and Architect/Engineer's administrative costs for answering its RFIs where the answer could reasonably be found by reviewing the Contract Documents, as determined by City; such costs will be deducted from progress payments.
 - 3. The City may initiate changes by issuing a Supplemental Instruction.
 - 4. Project Manager may initiate changes in the Work or Contract Time by issuing Requests for Proposal (RFP) to Contractor. Such RFPs will detail all proposed changes in the Work and request a quotation of changes in Contract Sum and Contract Time from Contractor.

1.3 PROCEDURE

- A. Contractor shall submit RFI to Project Manager in accordance with [Section 01 26 13 – Requests for Interpretation](#). Contractor shall reference each RFI to an activity of Progress Schedule and shall note time criticality of the RFI.
1. If Contractor is satisfied with the Clarification and does not request change in Contract Sum or Contract Time, then the Clarification shall be considered executed without a change.
 2. If Contractor believes that the Clarification results in change in Contract Sum or Contract Time, Contractor shall notify Project Manager who may then deny request for change or issue RFP.
- B. Contractor shall submit RFS to Project Manager who may then approve or deny request. If denied, Project Manager shall set forth in writing reasons for the denial. Contractor may revise and resubmit submittal with a rebuttal based on Section 3400 Public Contract Code CA. The RFS should set forth:
1. Reason for substitution
 2. Any deviations from Special Conditions or specifications
 3. Cost increase or decrease
 4. Any necessary revisions to drawings/related work
 5. Schedule impacts.
- C. Contractor shall submit Notices of Concealed or Unknown Conditions to resolve unanticipated conditions incurred in the execution of the Work. Procedures in [Division 00 - General Conditions](#) shall be followed. If Project Manager determines that a change in Contract Sum or Contract Time is justified, Project Manager shall issue RFP.
- D. Contractor shall submit Notices of Hazardous Waste Conditions to resolve problems regarding hazardous materials encountered in the execution of the Work. Procedures in [Division 00 - General Conditions](#) shall be followed. If Project Manager determines that a change in Contract Sum or Contract Time is justified, Project Manager shall issue RFP.
- E. Project Manager may issue Supplemental Instruction from the Architect/Engineer to Contractor. Contractor shall not proceed with Supplemental Instruction until Project Manager approves it in writing.
1. If Contractor is satisfied with Supplemental Instruction and does not request change in Contract Sum or Contract Time, then Supplemental Instruction shall be executed without a Change Order.
 2. If Contractor believes that Supplemental Instruction results in change in Contract Sum or Contract Time, Contractor shall notify Project Manager. Project Manager may then deny request for change, cancel Supplemental Instruction or issue RFP.
- F. If Project Manager issues to Contractor an RFP, then Contractor shall respond to the RFP within fifteen (15) working days by furnishing a complete breakdown of

costs of credits, deducts, extra costs or cost savings, resulting from the change in the Work. Contractor shall itemize materials, labor, taxes, overhead and profit. Subcontract work shall be so indicated.

- G. Upon approval of RFP, Project Manager will issue a Change Order directing Contractor to proceed with extra work. If the parties do not agree on the price for an RFP, the Project Manager may decide the issue per [Division 00 - General Conditions](#).
- H. Payment shall be made as follows:
 - 1. Change Orders which increase or decrease the Contract Sum or Contract Time shall be included by Contract Modification Form, signed by Project Manager, accepted by Contractor.
 - 2. Payment shall be made for Change Order work along with other work in progress payment following completion of Change Order work. Partial completion of Change Order work shall be paid for that part completed during the period covered by the monthly payment request.

1.4 COST DETERMINATION

- A. Total cost of extra work or of work omitted shall be the sum of labor cost (hourly rate plus employer paid benefits, taxes, insurance, etc.), material costs, equipment rental costs and specialist costs as defined herein plus overhead and profit as allowed herein. This limit applies in all cases of claims for extra work, whether calculating Change Orders, RFPs, or calculating claims of all types, and applies even in the event of fault, negligence, strict liability, or tort claims of all kinds, including strict liability or negligence. No other costs arising out of or connected with the performance of extra work, of any nature, may be recovered by Contractor. No special, incidental or consequential damages may be claimed or recovered against City, their officers, agents, employees, and consultants (including, but not limited to Architect/Engineer or Construction Manager), whether arising from breach of contract, negligence or strict liability, unless specifically authorized in the Contract Documents.
- B. Overhead and Profit:
 - 1. "Overhead and Profit" may also be referred to as "Markup".
 - 2. Overhead shall be defined in Paragraph 1.8 below.
 - 3. Overhead and profit on labor for extra work shall be thirty-five percent (35%).
 - 4. Overhead and profit on materials shall be fifteen percent (15%).
 - 5. Overhead and profit on equipment rental for extra work shall be fifteen percent (15%).
 - 6. When extra work is performed by a first tier subcontractor, Contractor shall receive a ten percent (10%) markup on subcontractors' total costs of extra work.
- C. Taxes:
 - 1. Contra Costa County Sales Tax shall be included.

2. Federal and Excise Tax shall not be included.

D. Owner Operated Equipment:

1. When owner-operated equipment is used to perform extra work, Contractor will be paid for equipment and operator as follows:
 - a. Payment for equipment will be made in accordance with Paragraph 1.5.C below.
 - b. Payment for cost of labor will be made at no more than rates of such labor established by collective bargaining agreements for type of worker and location of work, whether or not owner-operator is actually covered by such an agreement.

1.5 COST BREAKDOWN

A. Labor: Contractor will be paid cost of labor for workers (including forepersons when authorized by Project Manager) used in actual and direct performance of extra work. Labor rate, whether employer is Contractor, subcontractor or other forces, will be sum of following:

1. Actual Wages: Actual wages paid shall include any employer payments to or on behalf of workers for health and welfare, pension, vacation and similar purposes.
2. Labor Surcharge: Payments imposed by City, County, State and Federal laws and ordinances, and other payments made to, or on behalf of, workers, other than actual wages as defined in subparagraph 1 above, such as taxes and insurances. Labor surcharge shall be as set forth in California Department of Transportation official labor surcharges schedule which is in effect on date upon which extra work is accomplished and which schedule is incorporated herein by reference, as though fully set forth herein.

B. Material: Only materials furnished by Contractor and necessarily used in performance of extra work will be paid for. Cost of such materials will be cost, including sales tax, to purchaser (Contractor, subcontractor or other forces) from supplier thereof, except as the following are applicable:

1. If cash or trade discount by actual supplier is offered or available to purchaser, it shall be credited to City notwithstanding the fact that such discount may not have been taken.
2. For materials salvaged upon completion of extra work, salvage value of materials shall be deducted from cost, less discount, of materials.
3. If cost of a material is, in opinion of Project Manager, excessive, then cost of material shall be deemed to be lowest current wholesale price at which material is available in quantities concerned delivered to Site, less any discounts as provided in subparagraph 1 above.

C. Equipment Rental:

1. For Contractor- or subcontractor-owned equipment, payment will be made at rental rates listed for equipment in California Department of Transportation official equipment rental rate schedule which is in effect on date upon which

extra work is accomplished and which schedule is incorporated herein by reference as though fully set forth herein. For rented equipment, payment will be made based on actual rental invoices. Equipment used on extra work shall be of proper size and type. If, however, equipment of unwarranted size or type and cost is used, cost of use of equipment shall be calculated at rental rate for equipment of proper size and type. Rental rates paid shall be deemed to cover cost of fuel, oil, lubrication, supplies, small tools, necessary attachments, repairs and maintenance of any kind, depreciation, storage, insurance, and all incidentals. Unless otherwise specified, manufacturer's ratings, and manufacturer-approved modifications, shall be used to classify equipment for determination of applicable rental rates. Individual pieces of equipment or tools not listed in said publication and having a replacement value of five hundred dollars (\$500) or less, whether or not consumed by use, shall be considered to be small tools and no payment will be made therefore as payment is included in payment for labor. Rental time will not be allowed while equipment is inoperative due to breakdowns.

2. For equipment on Site, rental time to be paid for equipment shall be time equipment is in operation on extra work being performed or on standby as approved by Project Manager. The following shall be used in computing rental time of equipment:
 - a. When hourly rates are listed, less than thirty (30) minutes of operation shall be considered to be one-half (1/2) hour of operation.
 - b. When daily rates are listed, less than four (4) hours of operation shall be considered to be one-half (1/2) day of operation.
3. For equipment which must be brought to Site to be used exclusively on extra work, cost of transporting equipment to Site and its return to its original location shall be determined as follows:
 - a. City will pay for costs of loading and unloading equipment.
 - b. Cost of transporting equipment in low bed trailers shall not exceed hourly rates charged by established haulers.
 - c. Cost of transporting equipment shall not exceed applicable minimum established rates of California Public Utilities Commission.
 - d. Payment for transporting, and loading and unloading equipment as above provided will not be made if equipment is used on Work in any other way than upon extra work.
4. Rental period shall begin at time equipment is unloaded at Site of extra work and terminate at end of day on which City's Project Manager directs Contractor to discontinue use of equipment. Excluding Saturdays, Sundays, and legal holidays, unless equipment is used to perform extra work on such days, rental time to be paid shall be four (4) hours for zero (0) hours of operation, six (6) hours for four (4) hours of operation and eight (8) hours for eight (8) hours of operation, time being prorated between these parameters. Hours to be paid for equipment which is operated less than eight (8) hours due to breakdowns, shall not exceed eight (8) less number of hours equipment is inoperative due to breakdowns.

D. Work Performed by Special Forces or Other Special Services:

1. When the City's Project Manager and Contractor, by agreement, determine that special service or item of extra work cannot be performed by forces of Contractor or those of any subcontractors, service or extra work item may be performed by specialist. Invoices for service or item of extra work on basis of current market price thereof may be accepted without complete itemization of labor, material, and equipment rental costs when it is impracticable and not in accordance with established practice of special service industry to provide complete itemization. In those instances, wherein Contractor is required to perform extra work necessitating a fabrication or machining process in a fabrication or machine shop facility away from Site, charges for that portion of extra work performed in such facility may, by agreement, be accepted as a specialist billing. The City's Project Manager must be notified in advance of all off-site work. To specialist invoice price, less credit to City for any cash or trade discount offered or available, whether or not such discount may have been taken, will be added 15 percent (15%) in lieu of overhead and profit provided in Paragraph 1.4.B.

1.6 FORCE-ACCOUNT

- A. City may, at any time, require Contractor to perform Work on a Force Account (time and materials, cost not to exceed) basis. When Contractor performs Force Account Work, the labor, materials and equipment used in performing such Force Account Work shall be subject to City's approval.
- B. Whenever any Force-Account work is in progress, definite price for which has not been agreed on in advance, Contractor shall report to the City's Project Manager each day in writing in detail amount and cost of labor and material used, and any other expense incurred in Force-Account work on preceding work day as required herein. No claim for compensation for Force-Account work will be allowed unless report shall have been made. City may authorize Force Account Work with specific limits on price, which Contractor shall perform up to such limit.
- C. Force Account work shall be paid as extra work under this [Section 01 26 00 – Contract Modification Procedures](#). Above described methods of determining payment for work and materials shall not apply to performance of work or furnishings of material which, in judgment of the City's Project Manager, may properly be classified under items for which prices are established in Contract.

1.7 CITY FURNISHED MATERIALS

- A. City reserves right to furnish materials as it deems advisable, and Contractor shall have no claims for costs and overhead and profit on such materials.

1.8 OVERHEAD DEFINED

- A. The following constitutes charges that are deemed included in overhead for all contract modifications, including Force-Account work for the entire Contract Time:

1. Drawings: Field drawings, shop drawings, etc. including submissions of drawings
2. Routine field inspection of work proposed
3. General superintendence
4. General administration and preparation of change orders
5. Computer services
6. Reproduction services
7. Salaries of project engineer, project manager, superintendent, timekeeper, storekeeper and secretaries
8. Janitorial services
9. Temporary on-site facilities
10. Offices
11. Telephones
12. Plumbing
13. Electrical: Power, lighting
14. Platforms
15. Fencing, etc.
16. Home office expenses.
17. Insurance and Bond premiums.
18. Procurement and use of vehicles and fuel used coincidentally in base bid work.
19. Surveying
20. Estimating
21. Protection of work
22. Final cleanup
23. Other incidental work
24. Labor liability insurance

1.9 RECORDS AND CERTIFICATION

- A. Force-Account (cost reimbursement) charges shall be recorded daily upon Cost Breakdown for Contract Modification Form obtained from Inspector. Contractor or authorized representative shall complete and sign form. Inspector shall sign form for approval. Contract Modification Form shall provide names and classifications of workers and hours worked by each, itemize materials used, and also list size type and identification number of equipment, and hours operated, and shall indicate work done by specialists.
- B. No payment for Force-Account work shall be made until Contractor submits original invoices substantiating materials and specialist charges.
- C. City shall have the right to audit all records in possession of Contractor relating to activities covered by Contractor's claims for modification of Contract, including Force-Account work, as set forth in [Division 00 - General Conditions](#).
- D. Further, City shall have right to audit, inspect, or copy all records maintained in connection with this Contract, including financial records, in possession of

Contractor relating to any transaction or activity occurring or arising out of, or by virtue of, Contract. If Contractor is a joint venture, right of City shall apply collaterally to same extent to records of joint venture sponsor, and of each individual joint venture member.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION 01 26 00

DAILY EXTRA WORK REPORT

COST BREAKDOWN FORM FOR CONTRACT MODIFICATION
SHEET 1 OF 3

One separate form shall be used by Contractor, each first tier subcontractor and each lower tier subcontractor. One form for each shall be used for each change order. One form for each, for each day shall be used for Force-Account work.

CHANGE ORDER NUMBER: _____ DATE: _____

CHANGE ORDER DESCRIPTION: _____

CONTRACTOR: _____

LABOR				
NAME	CLASSIFICATION	HOURS	RATE	TOTAL
TOTAL LABOR COSTS (Enter here and on Line 1 of Sheet 3)				

COST BREAKDOWN FORM FOR CONTRACT MODIFICATION
SHEET 2 OF 3

MATERIALS	
DESCRIPTION	COST
TOTAL MATERIAL COSTS (Enter here and on Line 4 of Sheet 3)	

EQUIPMENT RENTAL				
SIZE AND TYPE	I.D. #	HOURS	RATE	TOTAL
TOTAL EQUIPMENT RENTAL COSTS (Enter here and on Line 8)				

SPECIALIST	
DESCRIPTION	COST
TOTAL SPECIALIST COSTS (Enter here and on Line 11)	

COST BREAKDOWN FORM FOR CONTRACT MODIFICATION
SHEET 3 OF 3

TOTAL COSTS		
1. TOTAL LABOR COSTS		
2. 10 % of Line 1		
3. ADD Lines 1 and 2		
4. TOTAL MATERIAL COSTS		
5. 10 % of Line 4		
6. 8.25 % of line 4		
7. ADD Lines 4, 5 and 6		
8. TOTAL EQUIPMENT RENTAL COSTS		
9. 10 % of Line 8		
10. ADD Lines 8 and 9		
11. TOTAL SPECIALIST COSTS		
12. 10 % of Line 11		
13. ADD Lines 11 and 12		
14. TOTAL COST OF EXTRA WORK (ADD Lines 3, 7, 10 and 13)		

CONTRACTOR OR AUTHORIZED REPRESENTATIVE: _____

APPROVED BY INSPECTOR: _____

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SECTION 01 26 13 – REQUESTS FOR INTERPRETATION**PART 1 - GENERAL**

1.1 SUMMARY

- A. This section describes procedural requirements for requests for interpretation, information, and/or clarification.
- B. Related Sections:
 - 1. [Division 00 – General Conditions](#)
 - 2. [Section 01 26 00 – Contract Modification Procedures](#)

1.2 GENERAL

- A. Description: Submit RFI to the Project Manager promptly upon identification of need, and in reasonable time so as not to affect the progress of the Work.
- B. Submission Procedures:
 - 1. Pre-submission Review: Before submitting request to the Project Manager, conduct a review to determine that the information requested, including items submitted by subcontractors or suppliers, is not shown in the Contract Documents.
 - 2. Category of Request: Submit requests for interpretation when one or more of the following conditions occur.
 - a. Need for Clarification: When information shown or indicated in the Contract Documents is unclear in its intent.
 - b. Unforeseen Condition: Discovery of unforeseen condition or circumstance that is not shown or indicated in the Contract Documents.
 - c. Conflict Within Documents: Discovery of an apparent inconsistency, conflict, or discrepancy between different portions of the Contract Documents, where the intent cannot be reasonably inferred from information shown or indicated.
 - d. Omission: Discovery of what appears to be an omission in the Contract Documents, where the intent cannot be reasonably inferred from information shown or indicated.
 - e. Coordination Problem: Discovery of unforeseen condition in coordinating placement of work that is specifically related to the Contract Documents.
 - 3. Unacceptable Requests:
 - a. General: Do not submit RFIs for confirmation of any action already taken by the Contractor. Requests will not be accepted that imply confirmation of any unauthorized change to the Work.

- b. **Untimely Submission:** An RFI that is submitted in a belated manner without proper coordination and scheduling of the Work of related subcontractors will not be reviewed and will be returned to the Contractor.
 - c. **Submittal:** An RFI that is included as part of a submittal will not be processed; see [Section 01 33 00 – Submittal Procedures](#).
 - d. **Substitution:** An RFI that is a request for substitution will not be processed; see [Section 01 25 00 – Substitution Procedures](#).
 - e. **Exclusionary Submission:** A request that implies that specific portions of the work are assumed to be excluded or considering a separate portion of the Contract Documents in part rather than as a whole will not be processed.
- C. **Log:** Prepare and maintain the official log of RFIs. Review status of log at each job progress meeting.

PART 2 - PRODUCTS

A. SUBMISSION REQUIREMENTS:

1. **Request for Interpretation (RFI) Form:**
 - a. **General:** Provide a completed and legible PDF of an RFI form that includes the following required information.
 - b. **RFI Number:** Identify RFIs sequentially starting from number one (1); number re-submissions with same number as original and add letter designation A, B, C, etc., in order submitted, until resolution is achieved.
 - c. **PDF Name:** Include RFI number and reference to name of project in file name; if space allows include brief description of subject in RFI file name.
 - d. **Contractor:** Provide company name and mailing address with signature of contact person responsible for work on the subject project, certifying to review of RFI.
 - e. **Subcontractor and/or Supplier** Provide company name, mailing address, telephone number and name and email of contact person responsible for work on the subject project.
 - f. **RFI Description:**
 - 1) **General:** Describe subject of RFI completely.
 - 2) **Drawing References:** Identify specific drawing number and/or detail number or note under consideration.
 - 3) **Specifications References:** Identify specification section number and paragraph number under consideration.
 - 4) **Attachments:** Identify as required, to support description.
 - 5) **Contractor's Proposed Resolution:**
 - a) **General:** Describe suggested resolution; support with attachments as required.

- b) Cost Impact: Indicate impact on costs; explain Contractor's original basis for bid and, based on the current request, reason that additional costs should be considered.
- c) Time Impact: Indicate effect on schedule; explain Contractor's original basis for bid and, based on the current request, why a time extension should be considered.

PART 3 - EXECUTION

A. PROJECT MANAGER'S RESPONSE:

- 1. General: Project Manager will respond on the RFI Form and include attachments, as referenced. Verbal responses to such requests are to be considered informational; official written response will only be given on annotated PDF of original RFI Form.
- 2. Project Manager's Review:
 - a. General: Allow ten (10) working days after receipt. If more than ten (10) requests are received within one (1) calendar week, the Project Manager will specifically schedule and extend response time as required to accomplish the reviews.
 - b. Prioritization: If more than five (5) requests have been received by the Project Manager, the Contractor shall identify the order of requests most critical to the schedule of the Project.

B. DISTRIBUTION:

- 1. General: Submit PDF of original, signed copy. PDF with the official response will be returned to the Contractor.
- 2. Consultants: The Project Manager will distribute copies of requests for information to project consultants, as required for their participation. Direct communication and response between project consultants and Contractor will be considered informational only.
- 3. Response: The Contractor will make and distribute copies of the official response to subcontractors and suppliers, as required.

END OF SECTION 01 26 13

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SECTION 01 29 00 – PAYMENT PROCEDURES**PART 1 - GENERAL**

1.1 SUMMARY

- A. This section describes the procedures for preparation and submittal of Progress Payment Requests.
- B. Related Sections:
 - 1. [Division 00 – General Conditions](#)
 - 2. [Section 01 32 16 - Construction Progress Schedule](#)

1.2 REFERENCES

- A. California Public Contract Code

1.3 SCOPE OF WORK

- A. Payment for the various items of the Schedule of Bid Prices, as further specified herein, shall include all compensation to be received by the Contractor for furnishing all tools, equipment, supplies, and manufactured products, and for all labor, operations, overhead and profit, applicable taxes, and incidentals appurtenant to the items of Work being described, as necessary to complete the various items of work as specified and as shown on the Drawings. No separate payment will be made for any item that is not specifically set forth in the Schedule of Bid Prices, and all costs therefore shall be included in the prices named in the Schedule of Bid Prices for the various appurtenant items of Work.
- B. Contract Prices shall be deemed to include all bonds and insurance, all appurtenances necessary to complete the required Work, including all costs for compliance with the regulations of the public agencies having jurisdiction, including Health and Safety Requirements of the California Division of Industrial Safety and the Occupational Safety and Health Administration of the U.S. Department of Labor (OSHA), and including all costs for loss or damage arising from the Work, or from action of the elements, for any unforeseen difficulties which may be encountered, and for all risks of every description connected with the prosecution of the Work until Project Completion, also for all expenses incurred in consequence of the suspension or discontinuance of the Work as provided in the Contract. Unless the Contract Documents expressly provide otherwise, the Contract Sum shall be deemed to include:
 - 1. Any and all costs arising from any unforeseen difficulties which may be encountered during, and all risks of any description connected with, prosecution of Work until acceptance by City;

2. All expenses incurred due to suspension, or discontinuance of Work as provided in Contract;
 3. Escalation to allow for cost increases between time of Contract Award and completion of Work.
- C. Whenever it is specified herein that Contractor is to do work or furnish materials of any class for which no price is fixed in the Contract, it shall be understood that Contractor is to do such work or furnish such materials without extra charge or allowance or direct payment of any sort, and that cost of doing work or furnishing materials is to be included in price bid, unless it is expressly specified herein, in particular cases, that work or material is to be paid for as extra work.
- D. Neither the payment of any estimate nor of any retained percentages shall relieve Contractor of its obligation to make good all defective work or material.

1.4 DETERMINATION OF QUANTITIES

- A. Quantity of work to be paid for under any item for which a unit price is fixed in Contract shall be number, as determined by Project Manager, of units of work satisfactorily completed in accordance with Drawings, Technical Specifications, and Specifications and as directed pursuant to Drawings, Technical Specifications, and Specifications. Unless otherwise provided, determination of number of units of work so completed will be based, so far as practicable, on actual measurement or count within prescribed or ordered limits, and no payment will be made for work done outside of limits. Measurements and computations will be made by methods as City's Project Manager may consider appropriate for class of work measured.

1.5 BASIS OF PAYMENT

- A. Unit Pay Quantities: When estimated quantity for specific portions of Work is listed in Bid Form, quantity of work to be paid for shall be actual number of units satisfactorily completed in accordance with Drawings, Technical Specifications, and Specifications.
- B. Lump Sum: When estimated quantity for specific portion of Work is not indicated and unit is designated as Lump Sum, payment will be on a Lump Sum basis for Work satisfactorily completed in accordance with Drawings, Technical Specifications, and Specifications.
- C. City does not expressly, or by implication, agree, warrant, or represent in any manner, that actual amount of Work will correspond with amount shown or estimated and reserves right to increase or decrease amount of any class or portion of Work, to leave out entire Bid Item or Items, or to add work not included in Bid, when in its judgment such change is in best interest of City. No change in Work shall be considered waiver of any other condition of Contract. No claim shall be made for anticipated profit, for loss of profit, for damages, or for extra payment whatever, except as otherwise expressly provided for in Contract Documents,

because of any differences between amount of work actually done and estimated amount as set forth herein, or for elimination of extra Bid Items.

- D. Monthly payment requests shall be based upon information developed at monthly Application for Payment meetings and shall be prepared by Contractor. The approved Schedule of Values will be the basis for Contractor's payment requests.
1. No partial progress payment shall be made to Contractor until all cost information requested by the City is submitted and reviewed.
 2. The following information shall also be submitted with and as part of the Contractor's progress payment application; all information, noted below, will cover the same period of the progress payment application.
 - a. Progress Schedule: Submittal of one (1) copy of the progress schedule updated to include the progress achieved as of the date of the Application for Payment in accordance with this Section.
 - 1) Contractor shall, at the time any payment request is submitted, certify in writing the accuracy of the payment request and that Contractor has fulfilled all scheduling requirements of [Division 00 – General Conditions](#) and [Section 01 32 16 - Construction Progress Schedule](#), including updates and revisions. The certification shall be executed by a responsible officer of the Contractor.
 - b. Project Record Drawings: Submit project record drawings with each progress payment application for the City's Project Manager's review. The drawings shall be returned to the Contractor within fourteen (14) calendar days of submittal.
 - c. Certified Payroll: Certified payroll for all Contractor and subcontractor staffing pursuant to Section 1776 of the California Labor Code and including all subcontractors, suppliers, or creditors for all labor and materials incorporated into the work.
 - d. Lien Releases: Conditional or Unconditional lien release for the requested payment. Unconditional lien release for the previous payment.
 3. No progress payment will be processed prior to Project Manager receiving all requested information.
- E. The City will not be liable for costs arising from the delay in making progress payments.

1.6 PROGRESS PAYMENT PROCEDURES

- A. If requested by Contractor, progress payments will be made monthly.

B. Schedule of Values:

1. Within ten (10) calendar days from issuance of Notice of Award and prior to the Contractor's application for the first progress payment, the Contractor shall submit a detailed breakdown of its bid by scheduled Work items and/or activities. This breakdown shall be referred to as the Schedule of Values.
2. If City's Project Manager requires substantiating data, Contractor shall submit information requested by Project Manager, with cover letter identifying Project, payment request number and date, and detailed list of enclosures. Contractor shall submit one copy of substantiating data and cover letter for each Payment request submitted.

C. Payment Requests:

1. On or about the 25th of each month, the Contractor may submit to the City's Project Manager one (1) copy of an itemized Application of Payment on a standard form acceptable to the City's Project Manager covering the Work completed as of the date of the Application for payment. The following information and/or documentation will be provided as part of the Application for Payment:
 - a. Payment requests may include, but not necessarily limited to the following:
 - 1) Materials, equipment, and labor incorporated into the Work, less any previous payments for the same;
 - 2) A maximum of ninety percent (90%) of the cost of major equipment, if purchased and delivered to the site or stored offsite, as under control of the City, but not installed by the Contractor.
 - 3) Contractor's application for payment shall be accompanied by a bill of sale, invoice, or other documentation warranting that the City has received the materials and equipment free and clear of all liens and evidence that the materials and equipment area covered by appropriate property insurance and other arrangements to protect the City's interest therein.
 - b. Such requests for progress payments shall be based upon Schedule of Values prices of all labor and materials incorporated in the Work during the preceding one-month period, less the aggregate of previous payments.
 - c. Each payment request shall list each Change Order executed prior to the date of submission, including the Change Order Number, a description of the work activities, consistent with the descriptions of original work activities.
 - 1) Contractor shall submit a monthly Change Order status log to the City's Project Manager as part of that Progress Payment Request.
2. Monthly progress payments shall be made, based on total value of activities completed or partially completed, as determined by City with participation of Contractor, and based upon approved activity costs. Accumulated retainage will be shown as separate item in payment summary. If Contractor fails or

refuses to participate in construction progress evaluation with City, Contractor shall not receive current payment until Contractor has participated fully in providing construction progress information and schedule update information for City.

D. Progress Payments:

1. Upon receiving Contractor's payment request, Project Manager will review the payment request and make necessary adjustments to percent of completion of each activity. One copy will be returned to Contractor with description of adjustments made. All parties will update percentage of completion values in the same manner, i.e., express value of an accumulated percentage of completion to date.
2. The payment request may be reviewed by Project Manager for the purpose of determining that the payment request is a proper payment request, and shall be rejected, revised or approved by Project Manager pursuant to the cost breakdown prepared in accordance with this Section.
3. If it is determined that the payment request is not a proper payment request suitable for payment, Project Manager shall return it to the Contractor as soon as practicable, but no later than seven (7) working days after receipt, together with a document setting forth in writing the reasons why the payment request is not proper. If Project Manager determines that portions of the payment request are not proper or not due under the Contract Documents, then Project Manager may approve the other portions of the payment request and, in the case of disputed items or defective work not remedied, may withhold up to 150% of the disputed amount from the progress payment.
4. Pursuant to Public Contract Code, Section 20104.50, if City fails to make any progress payment within thirty (30) days after receipt of an undisputed and properly submitted payment request from a contractor, City shall pay interest to the Contractor equivalent to the legal rates set forth in subdivision (a) of Section 685.010 of the Code of Civil Procedure. The thirty (30) day period shall be reduced by the number of days by which City exceeds the seven (7) day return requirement set forth herein.
5. As soon as practicable after approval of each request for progress payment, City will pay to Contractor in manner provided by law, the amounts provided for below:
 - a. City shall pay an amount equal to ninety percent (90%) of Project Manager's estimate, which amount shall remain in effect until such time, if any, that the retention is reduced by Project Manager pursuant to the other provisions of this paragraph.
 - b. At any time after fifty percent (50%) in value of the Work as set forth in the Schedule of Values has been completed and the retained funds are equal to five percent (5%) of the Contract Sum (including Change Orders, if applicable), and if the progress of the Work under the Progress Schedule is satisfactory, Project Manager may, at its sole discretion, but shall not be obligated to, authorize any remaining

- progress payment to be made in the amount of ninety-five percent (95%) of the amount approved for payment.
- c. When Project Manager determines that at least ninety-five percent (95%) in value of the Work as set forth in the Schedule of Values is completed, Project Manager may, at its sole discretion, but shall not be obligated to, reduce the amount of the retained funds to one hundred twenty-five percent (125%) of the value of the Work yet to be completed, as determined by Project Manager.
 - d. After all Work is completed in accordance with Contract, the remaining retention amount shall be paid to the Contractor in accordance with Paragraph 1.9, below.
 - e. If a lesser payment amount is provided in the Contract Documents, such lesser amount shall apply instead of the amounts set forth above in this paragraph.
 - f. Progress payments may at any time be withheld if, in judgment of Project Manager, Work is not proceeding in accordance with Contract, or Contractor is not complying with requirements of Contract, or to comply with stop notices or to offset liquidated damages accruing or expected.
6. Retention will not be reduced if Contractor, in the opinion of the Project Manager, is behind schedule. If retention is reduced at any point during Contract and Contractor subsequently falls behind schedule, retention may be raised back to original percentage.
 7. Before any progress payment or final payment is made, the Contractor may be required to submit satisfactory evidence that Contractor is not delinquent in payments to employees, subcontractors, suppliers, or creditors for labor and materials incorporated into Work.
 8. City reserves and shall have the right to withhold payment for any equipment and/or specifically fabricated materials that, in the sole judgment of Project Manager, is not adequately and properly protected against weather and/or damage, prior to or following incorporation into the Work.
 9. Approval of progress payment and payment by City, or receipt thereof by Contractor, shall not be understood as constituting in any sense acceptance of Work or of any portion thereof, and shall in no way lessen liability of Contractor to replace unsatisfactory work or material, though unsatisfactory character of work or material may have been apparent or detected at time payment was made.
 10. When City shall charge sum of money against Contractor under any provision of Contract, amount of charge shall be deducted and retained by City from amount of next succeeding progress payment or from any other monies due or that may become due Contractor under Contract. If, on completion or termination of Contract, such monies due Contractor are found insufficient to cover City's charges against Contractor, City shall have right to recover balance from Contractor or Sureties.

1.7 SUBSTITUTION OF SECURITIES IN LIEU OF RETENTION

- A. Pursuant to provisions of Public Contract Code, Section 22300, substitution of securities for any monies withheld under Contract to insure performance is permitted under the following conditions:
1. At request and expense of Contractor, securities listed in Section 16430 of the Government Code, bank or savings and loan certificates of deposit, interest bearing demand deposit accounts, standby letters of credit, or any other security mutually agreed to by Contractor and City which are equivalent to the amount withheld under retention provisions of Contract shall be deposited with Controller or with a state or federally chartered bank in California, as the escrow agent, who shall then pay such monies to Contractor. Upon satisfactory completion of Contract, securities shall be returned to Contractor.
 2. Alternatively, Contractor may request and City shall make payment of retentions earned directly to the escrow agent at the expense of the Contractor. At the expense of the Contractor, the Contractor may direct the investment of the payments into securities and the Contractor shall receive the interest earned on the investments upon the same terms provided for in this section for securities deposited by the Contractor. Upon satisfactory completion of the Contract, the Contractor shall receive from escrow agent all securities, interest, and payments received by the escrow agent from City, pursuant to the terms of this section. The Contractor shall pay to each subcontractor, not later than twenty (20) days after receipt of the payment, the respective amount of interest earned, net of costs attributed to retention withheld from each subcontractor, on the amount of retention withheld to insure the performance of the Contractor.
 3. Contractor shall be beneficial owner of securities substituted for monies withheld and shall receive any interest thereon.
 4. Contractor shall enter into escrow agreement with Controller according to Document 00 53 00 - Escrow Agreement for Security Deposits in Lieu of Retention, as authorized under Public Contract Code, Section 22300, specifying amount of securities to be deposited, terms and conditions of conversion to cash in case of default of Contractor, and termination of escrow upon completion of Contract.

1.8 APPLICATION FOR PAYMENT OF SUBSTANTIAL COMPLETION

- A. Following issuance of the Certificate of Substantial Completion, submit an Application for Payment.
1. This application shall reflect Certificates of Partial Substantial Completion issued previously for City occupancy of designated portions of the Work.
 2. Administrative actions and submittals that shall precede or coincide with this application include:
 - a. Occupancy permits and similar approvals.

- b. Warranties, guarantees, and maintenance agreements.
- c. Test/adjust/balance records.
- d. Operations and Maintenance instructions.
- e. Meter readings.
- f. Startup performance reports.
- g. Changeover information related to City's occupancy, use, operation, and maintenance.
- h. Final cleaning.
- i. Application for reduction of retainage and consent of surety.
- j. Final progress photographs.
- k. List of incomplete Work, recognized as exceptions to Architect/Engineer's Certificate of Substantial Completion.

1.9 FINAL PAYMENT

- A. As soon as practicable after all required Work is completed in accordance with Contract, including Contractor maintenance after Final Acceptance, City will pay to Contractor, in manner provided by law, unpaid balance of contract price of Work, or whole contract price of Work if no progress payment has been made, determined in accordance with terms of Contract, less sums as may be lawfully retained under any provisions of Contract or by law.
- B. Prior progress payments shall be subject to correction in the final payment. Project Manager's determination of amount due as final payment shall be final and conclusive evidence of amount of Work performed by Contractor under Contract, and shall be full measure of compensation to be received by Contractor.
- C. Contractor and each assignee under an assignment in effect at time of final payment shall execute and deliver at time of final payment and as a condition precedent to final payment, Agreement Form, and Release of Any and All Claims, discharging City of Pittsburg, their officers, agents, employees, and consultants (including, but not limited to Architect/Engineer and Construction Manager) of and from liabilities, obligations, and claims arising under Contract.
- D. Final Payment Application: Administrative actions and submittals that must precede or coincide with submittal of the final Application for Payment include the following:
 - 1. Completion of Project closeout requirements.
 - 2. Completion of items specified for completion after Substantial Completion.
 - 3. Ensure that unsettled claims will be settled.
 - 4. Ensure that incomplete Work is not accepted and will be completed without undue delay.
 - 5. Transmittal of required Project construction records to the City.
 - 6. Certified property survey.
 - 7. Proof that taxes, fees, and similar obligations were paid.
 - 8. Removal of temporary facilities and services.
 - 9. Removal of surplus materials, rubbish, and similar elements.

10. Change of door locks to City's access.
11. All as-built drawings.
12. Lien releases from Contractor and subcontractors.

1.10 EFFECT OF PAYMENT

- A. Payment will be made by City, based on Project Manager's observations at the site and the data comprising the Application for Payment. Payment will not be a representation that Project Manager has:
1. made exhaustive or continuous on-site inspections to check the quality or quantity of Work;
 2. reviewed construction means, methods, techniques, sequences or procedures;
 3. reviewed copies of requisitions received from subcontractors and material suppliers and other data requested by City to substantiate Contractor's right to payment; or
 4. made examination to ascertain how or for what purpose Contractor has used money previously paid on account of the Contract Sum.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION 01 29 00

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SECTION 01 31 00 – PROJECT MANAGEMENT AND COORDINATION**PART 1 - GENERAL**

1.1 SUMMARY

- A. This section describes requirements for coordination and meetings.
- B. Related Sections:
 - 1. [Division 00 – General Conditions, Article 2](#)
 - 2. [Section 01 32 16 - Construction Progress Schedule](#)

1.2 COORDINATION

- A. The Contractor shall be responsible for all Project coordination.
- B. Duties of Contractor:
 - 1. Coordinate Work of all subcontractors.
 - 2. Establish on-site lines of authority and communication. Schedule and conduct progress meetings with City and subcontractors.
 - 3. Construction schedules:
 - a. Prepare detailed schedule of operations of all subcontractors on Project in accordance with [Section 01 32 16 – Construction Progress Schedule](#).
 - b. Monitor and update schedules as Work progresses.
 - c. Observe Work to monitor compliance with schedule.
 - 4. Temporary facilities:
 - a. Prepare temporary facilities site plan for City's approval.
 - b. Allocate space for temporary structures furnished by subcontractors.
 - c. Monitor use of temporary utilities.
 - d. Verify that adequate services are provided to comply with requirements for Work and climatic conditions.
 - e. Coordinate traffic control.
 - f. Administer traffic and parking controls.
 - 5. Changes:
 - a. Recommend necessary or desirable changes to Architect/Engineer.
 - b. Review subcontractor's request for changes and for substitutions.
 - c. Submit recommendations to Architect/Engineer, through the Project Manager.
 - d. Process Change Orders.
 - 6. Permits and fees: Verify that subcontractors have obtained permits for inspections.
 - 7. Review all Shop Drawings, Product Data, and Samples for compliance with Contract Documents prior to submittal to Project Manager.

8. Interpretation of Contract Documents:
 - a. Consult with Project Manager and Architect/Engineer to obtain interpretations.
 - b. Assist in resolution of questions which may arise.
 - c. Transmit written interpretations to concerned parties.
9. Maintain reports and records at Project Site:
 - a. Daily log progress of Work; make available to Project Manager and Architect/Engineer.
 - b. Records.
 - c. Contracts.
 - d. Purchases.
 - e. Materials and equipment.
 - f. Applicable handbooks, codes and standards.
 - g. Obtain information from subcontractors and maintain record documents. Assemble documentation for handling of claims and disputes.
10. Verify that specified cleaning is done during progress of Work and at completion of each contract.
11. For project requiring building permit, coordinate with the Building Division, City of Pittsburg, for inspections.
12. Start-up:
 - a. Direct the checkout of utilities, operational systems and equipment.
 - b. Assist in initial start-up testing.
 - c. Record dates of start of operation of systems and equipment.
 - d. Submit to City written notice of beginning of Warranty period for equipment put in service.

1.3 COORDINATION REQUIREMENTS

- A. Coordination: Contractor shall coordinate the Work as stated in the [Division 00 – General Conditions](#). Contractor shall also coordinate Work under the Contract with work under separate contracts by City. Contractor shall cooperate with City and others as directed by City in scheduling and sequencing the incorporation into the Work of City Furnished/Contractor installed products identified in the Contract Drawings, Special Conditions, and Specifications.
- B. Relationship of Contract Documents: Drawings, Special Conditions, Specifications, and other Contract Documents in the Project Manual are intended to be complementary. What is required by one shall be as if required by all. What is shown or required, or may be reasonably inferred to be required, or that is usually and customarily provided for similar work, shall be included in the Work.
- C. Discrepancies in Contract Documents: In the event of error, omission, ambiguity or conflict in Drawings, Special Conditions, or Specifications, Contractor shall bring the matter to the Architect/Engineer's attention, through the Project Manager, in a timely manner, for the Architect/Engineer's determination and direction in accordance with provisions of [Division 00 – General Conditions](#).

- D. Construction Interfacing and Coordination: Layout, scheduling and sequencing of Work shall be solely Contractor's responsibility. Contractor shall bring together the various parts, components, systems, and assemblies as required for the correct interfacing and integration of all elements of Work.
- E. Contractor shall coordinate Work to correctly and accurately connect abutting adjoining, overlapping and related elements, including work under separate contracts by City, utility agencies and companies.

1.4 COORDINATION OF SUBCONTRACTS AND SEPARATE CONTRACTS

- A. Superintendence of Work: Contractor shall appoint a field superintendent who shall directly supervise and coordinate Work shown on the Drawings, Special Conditions, and in the Specifications at all times. In order to maintain an uninterrupted construction schedule, the field superintendent shall not be replaced by the Contractor, for other than extenuating circumstances, without prior approval by the Architect/Engineer and/or City.
- B. Subcontractors, Trades and Materials Suppliers: Contractor shall require all subcontractors, trades, crafts and suppliers to coordinate their portions of Work with the Superintendent, Engineer and Construction Project Manager to prevent scheduling, sequencing, dimensional and other conflicts and omissions.
- C. Coordination with Work under Separate Contracts: Contractor shall coordinate and schedule Work under the Contract with work being performed for Project under separate contracts by City, serving utilities and public agencies. Contractor shall make direct contacts with parties responsible for work of the Project under separate contracts, in order to provide timely notifications and to facilitate information exchanges.

1.5 PRECONSTRUCTION CONFERENCE

- A. Project Manager will call for and administer Preconstruction Conference at time and place to be announced. Conference will occur as soon after award as can be reasonably scheduled.
- B. Contractor, all subcontractors, and major suppliers shall attend Preconstruction Conference.
- C. Agenda will include, but not be limited to, the following items:
 - 1. Lines of Communication
 - 2. Schedules
 - 3. Employment Goals
 - 4. Personnel
 - 5. Use of premises
 - 6. Location of Contractor's on-site facilities
 - 7. Project access

8. Employee parking
9. Security
10. NPDES Storm Water Pollution Prevention BMPs
11. Contractor's Questions
12. Housekeeping
13. Submittals
14. Inspection and testing procedures, on-site and off-site
15. Utility shutdown procedures
16. Control and reference point survey procedures
17. Injury and Illness Prevention Program
18. Contractor's Initial CPM Schedule
19. Preparation of Record Documents.

- D. Project Manager will distribute copies of minutes to attendees. Attendees shall have five (5) working days to submit comments or additions to minutes. Minutes will constitute final memorialization of results of the Preconstruction Conference.

1.6 SCHEDULING MEETINGS

- A. Meet with Project Manager no later than Start Date of Contract and conduct initial review of Contractor's Initial Progress Schedule submittal, draft Shop Drawing and Sample Submittal Schedule, and draft Schedule of Values ("Schedule Review Meeting").
- B. Authorized representative in Contractor's organization, designated in writing, who will be responsible for working and coordinating with Project Manager's representative(s) relative to preparation and maintenance of Progress Schedule, shall attend initial Schedule Review Meeting.
- C. Contractor shall, within thirty (30) calendar days from the Notice to Proceed date, meet with City to review Contractor's Original CPM Schedule submittal, and final Shop Drawing and Sample Submittal Schedule, and final Schedule of Values.
 1. Contractor shall have its manager, superintendent, scheduler, and key subcontractor representatives, as required by City, in attendance. The meeting will take place over a continuous one-day period.
 2. City's review of Schedule Submittals will be limited to conformance to Contract requirements, including, but not limited to, coordination requirements. However, review may also include:
 - a. Clarifications of Contract Requirements
 - b. Directions to include activities and information missing from submittal
 - c. Requests to Contractor to clarify its schedule
 3. Within five (5) working days of the initial Schedule Review Meeting, Contractor shall respond in writing to all questions and comments expressed by City at the meeting.
- D. Project Manager will administer scheduling meetings and shall distribute minutes of scheduling meetings to attendees. Attendees shall have five (5) working days

to submit comments or additions to minutes. Minutes will constitute final memorialization of results of the scheduling meetings.

1.7 PROGRESS MEETINGS

- A. A progress meeting will be held weekly to review the schedule update submittal and progress payment application. At this meeting, at a minimum, the following items will be reviewed:
1. Previous meeting notes.
 2. Percent complete of each activity
 3. Time impact evaluations for Change Orders and Time Extension Request
 4. Actual and anticipated activity sequence changes
 5. Actual and anticipated duration change
 6. Actual and anticipated contractor delays
 7. Interface requirement
 8. Status on submittals
 9. Documentation of information for payment request.
- B. These meetings are considered a critical component of overall monthly schedule update submittal and Contractor shall have appropriate personnel attend. At a minimum, these meetings shall be attended by Contractor's General Superintendent and Scheduler.
- C. Project Manager will record and distribute minutes to Contractor, Building and/or Special Inspector, Architect/Engineer, and all other participants, and those affected by decisions made at the meeting, within five (5) working days after the meeting. Attendees shall have five (5) working days to submit comments or additions to the minutes. The Minutes will constitute final memorialization of the results of the progress meeting.

1.8 SPECIAL MEETINGS

- A. Special meetings may be called by any party by notifying all desired participants, Project Manager, and Building and/or Special Inspector five (5) working days in advance, giving reason for meeting. Special Meetings may be held without advance notice in emergency situations.
- B. At any time during the progress of the Work, any party shall have the right to require attendance at conference, and notice of such conference shall be duly observed and complied with by Contractor.
- C. Contractors shall schedule and conduct coordination meetings as necessary to discharge coordination responsibilities in [Division 00 – General Conditions](#). Project Manager shall be given five (5) working days written notice of coordination meetings. Contractors shall maintain minutes of coordination meetings. Attendees shall have five (5) working days to submit comments or additions to minutes. Minutes will constitute final memorialization of results of the meetings.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION 01 31 00

SECTION 01 32 00 – CONSTRUCTION PROGRESS DOCUMENTATION**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Preconstruction photographs and videos.
2. Periodic construction photographs and videos.

B. Submittals:

1. Key Plan: Submit key plan of project site and construction with notation of vantage points marked for location and direction of each photograph and video.
2. Construction Photographs: Submit digital copy of photographs in PDF and JPEG form in a CD or a USB flash drive with a folder containing pictures of each street in subfolders.
3. Identification: Identify the project by Contract Number. Identify each photograph by naming it according to the station number on the drawings. Example: Sta 10+00 looking northeast; Sta 12+30 looking west.
4. Digital Images:
 - a. General: Identify electronic media with date photographs were taken. Submit images that have same aspect ratio as the sensor, uncropped.
 - b. Usage Rights: Submit statement of transfer copyright usage rights to City allowing unlimited reproduction of photographic documentation.
5. Video:
 - a. General: Submit videos on acceptable electronic transfer medium to the Project Manager, accompanied by a detailed log, including descriptions and corresponding counter numbers to facilitate the quick location of information. Videos will be maintained by the Project Manager during construction and may be viewed at any time by Contractor upon request. Upon final acceptance, the videos will become the permanent property of the City.
 - b. Submit video documentations to the Project Manager prior to start of construction work and as otherwise required.
 - c. Usage Rights: Submit statement of transfer copyright usage rights to City allowing unlimited reproduction of videographic documentation.

PART 2 - PRODUCTS

2.1 PHOTOGRAPHIC MEDIA

- A. Digital Images: Provide images capable of a digital capture resolution of not less than 2240x1680 - 4 Megapixels.

- B. Videos: Provide videos in high resolution digital format with audio capability.

PART 3 - EXECUTION

3.1 CONSTRUCTION PHOTOGRAPHS

- A. General: Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.
- B. Key Plan: Maintain with each set of construction photographs that identifies each photographic location.
- C. Digital Images:
 - 1. General: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
 - 2. Date and Time: Include date and time in filename for each image.
 - 3. Field Office Images: Maintain one set of images on acceptable electronic transfer medium in the field office at Project Site, available at all times for reference. Identify images same as for those submitted to Project Manager.
- D. Preconstruction Photographs:
 - 1. General: Before starting construction, take color photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Project Manager.
 - 2. Construction Limits: Flag before taking construction photographs.
 - 3. Adjacent Conditions:
 - a. General: Take three (3) color photographs, from different views, to show existing conditions adjacent to property before starting the Work.
 - b. Existing Buildings: Take three (3) color photographs, different views, of existing buildings either on or adjoining property to accurately record physical conditions at start of construction.

3.2 CONSTRUCTION VIDEOS

- A. Preconstruction Videos: Document existing conditions of adjacent areas (curbs, gutters, sidewalks, driveways, private improvements immediately adjacent to the project site, roadway pavement, access roads, landscaping, etc.) that might be affected by construction operations. Take care to record all existing conditions which exhibit deterioration, imperfections, structural failures, or situations that would be considered substandard.
- B. All Videos: Provide temporary lighting as necessary to properly videotape areas where natural lighting is insufficient (shadows, etc.). Include an audio soundtrack to provide the following information:

1. Detailed description of location being viewed.
2. Direction (N, E, S, W, looking up, looking down, etc.) of camera view.
3. Date, time, temperature, environmental conditions at time of videotaping.
4. Describe in detail areas not readily visible by video. Unless otherwise approved by the Project Manager, do not perform videotaping during inclement weather or when the ground is covered partially or totally with leaves or debris.

END OF SECTION 01 32 00

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SECTION 01 32 16 – CONSTRUCTION PROGRESS SCHEDULE**PART 1 - GENERAL**

1.1 SUMMARY

- A. Scheduling of Work under this Contract shall be performed by Contractor in accordance with requirements of this Section.
 - 1. Development of schedule, cost and resource loading of the schedule, monthly payment requests and project status reporting requirements of the Contract shall employ scheduling as required in this Document.
 - 2. The Schedule shall be cost loaded based on Schedule of Values as approved by City.
 - 3. Submit schedules and reports as specified in [Division 00 – General Conditions](#).
- B. Upon Award of Contract, Contractor shall immediately commence development of Initial Schedule to ensure compliance with schedule submittal requirements.
- C. Related Sections
 - 1. [Contract](#)
 - 2. [Division 00 – General Conditions, Article 5](#)
 - 3. [Section 01 10 00 – Summary](#)
 - 4. [Section 01 29 00 – Payment Procedures](#)
 - 5. [Section 01 31 00 – Project Management and Coordination](#)
 - 6. [Section 01 33 00 – Submittal Procedures](#)

1.2 GENERAL

- A. Progress Schedule shall be based on and incorporate milestone and completion dates specified in Contract Documents.
- B. Overall time of completion and time of completion for each milestone shown on Progress Schedule shall adhere to times in the [Contract](#), unless an earlier (advanced) time of completion is requested by Contractor and agreed to by City. Any such agreement shall be formalized by a Change Order.
 - 1. City is not required to accept an earlier (advanced) schedule, i.e., one that shows early completion dates for the Contract Times.
 - 2. Contractor shall not be entitled to extra compensation in event agreement is reached on an earlier (advanced) schedule and Contractor completes its Work, for whatever reason, beyond completion date shown in earlier (advanced) schedule but within the Contract Times.
 - 3. A schedule showing the work completed in less than the Contract Times, which has been accepted by City, shall be considered to have Project Float. The Project Float is the time between the scheduled completion of the work

and Contract Substantial Completion. Project Float is a resource available to both City and Contractor.

- C. Progress Schedule shall be the basis for evaluating job progress, payment requests, and time extension requests. Responsibility for developing Contract schedule and monitoring actual progress as compared to Progress Schedule rests with Contractor.
- D. Failure of Progress Schedule to include any element of the Work or any inaccuracy in Progress Schedule will not relieve Contractor from responsibility for accomplishing the Work in accordance with the Contract. City's acceptance of Schedule shall be for its use in monitoring and evaluating job progress, payment requests, and time extension requests, and shall not, in any manner, impose a duty of care upon City, or act to relieve Contractor of its responsibility for means and methods of construction.
- E. Transmit each item per [Section 01 33 00 – Submittal Procedures](#) under form approved by City.
 - 1. Identify Project with the City Contract number, and name of Contractor.
 - 2. Provide space for Contractor's approval stamp and City's review stamps.
 - 3. Submittals received from sources other than Contractor will be returned to Contractor without City's review.

1.3 INITIAL AND ORIGINAL SCHEDULE

- A. Initial Schedule submitted for review at the pre-construction conference shall serve as Contractor's schedule for up to thirty (30) calendar days after the Notice to Proceed.
- B. Indicate detailed plan for the Work to be completed in first thirty (30) calendar days of the Contract; details of planned mobilization of plant and equipment; sequence of early operations; and procurement of materials and equipment. Show Work beyond thirty (30) calendar days in summary form.
- C. Original (or "Baseline") Schedule shall be submitted for review no later than Contractor's first progress payment application submittal.
- D. All schedules shall be time-scaled.
- E. All schedules shall be cost and resource loaded. Accepted cost and resource loaded schedule will be used as basis for monthly progress payments. Use of Initial Schedule for progress payments shall not exceed thirty (30) calendar days.
- F. City and Contractor shall meet to review and discuss the Schedule within seven (7) calendar days after it has been submitted to City.
 - 1. City's review and comment on the schedule shall be limited to Contract conformance (with sequencing, coordination, and milestone requirements).

2. Contractor shall make corrections to Schedule necessary to comply with Contract requirements and shall adjust Schedule to incorporate any missing information requested by City. Contractor shall resubmit Initial Schedule if requested by City.

1.4 CONSTRUCTION SCHEDULE FORMAT AND LEVEL OF DETAIL

- A. The Construction Schedule is to indicate all separate fabrication and field construction activities required for completion of the work, including but not limited to the following:
 1. All Contractor, Subcontractor and assigned Contractor work shall be shown in a logical work sequence that demonstrates a coordinated plan of work for all contractors. The intent is to provide a common basis of acceptance, understanding and communication, as well as interface with other contractors.
 2. Activities related to the delivery of City-furnished equipment to be contractor-installed per Contract shall be shown.
 3. All activities shall be identified through codes or other identification to indicate the building (i.e. buildings, site work) and Contractor/subcontractor responsibility to which they pertain.
 4. Contractor shall break up the work schedule into activities of durations of approximately fifteen (15) calendar days or less each, except for non-field construction activities or as otherwise deemed acceptable by the Project Manager.
- B. Seasonal weather conditions (which do not constitute a delay as defined herein) shall be considered in the planning and scheduling of all work influenced by high or low ambient temperatures or presence of high moisture for the completion of the work within the allotted contract time.
- C. In conformance with the Contract Documents Contractor shall furnish a breakdown of the bid by assigning dollar values (cost estimated) to each applicable network activity, which cumulatively equals the bid. Upon acceptance by City, the values will be used as the basis for determining progress payments. Contractor's overhead, profit, and cost of bonds and insurance, shall be prorated through all activities.
- D. Failure by Contractor to include any element of work required for performance of the work on the detailed construction schedule shall not excuse Contractor from completing all work required within the Contract time.
- E. A two-week "look ahead" detailed, daily bar chart schedule shall be updated and issued weekly, no later than the time of the scheduled weekly meeting.
- F. Contractor shall utilize computer scheduling software, such as PRIMAVERA or approved equivalent software for all scheduling including schedule updates.

Contractor shall supply computer data files for all schedules including the original schedule and monthly schedule updates.

1.5 MONTHLY SCHEDULE UPDATE SUBMITTALS

- A. Following acceptance of Contractor's Initial Schedule, Contractor shall monitor progress of Work and adjust schedule each month to reflect actual progress and any anticipated changes to planned activities.
 - 1. Each schedule update submitted shall be complete, including all information requested for the Initial Schedule submittal.
 - 2. Each update shall continue to show all work activities including those already completed. These completed activities shall accurately reflect "as built" information by indicating when activities were actually started and completed.
- B. A meeting will be held after the first Project Meeting of each month to review the schedule update submittal and progress payment application.
 - 1. At this meeting, at a minimum, the following items will be reviewed: percent complete of each activity; time impact evaluations for change orders and time extension requests; actual and anticipated activity sequence changes; actual and anticipated duration changes; and actual and anticipated contractor delays.
 - 2. These meetings are considered a critical component of overall monthly schedule update submittal and Contractor shall have appropriate personnel attend. At a minimum, these meetings shall be attended by Contractor's General Superintendent and Scheduler.
 - 3. Contractor shall plan on the meeting taking no less than two (2) hours.
- C. Within five (5) working days after monthly schedule update meeting, Contractor shall submit the updated Schedule update.
- D. Within five (5) working days of receipt of above noted revised submittals, City will either accept or reject monthly schedule update submittal.
 - 1. If accepted, percent complete shown in monthly update will be basis for Application for Payment by Contractor. The schedule update shall be submitted as part of Contractor's Application for Payment.
 - 2. If rejected, update shall be corrected and resubmitted by Contractor before the Application for Payment is submitted.
- E. Neither updating, changing or revising of any report, curve, schedule or narrative submitted to City by Contractor under this Contract, nor City's review or acceptance of any such report, curve, schedule or narrative, shall have the effect of amending or modifying, in any way, the Contract Substantial Completion date or milestone dates or of modifying or limiting, in any way, Contractor's obligations under this Contract.

1.6 SCHEDULE REVISIONS

- A. Updating the Schedule to reflect actual progress shall not be considered revisions to the Schedule. Since scheduling is a dynamic process, revisions to activity durations and sequences are expected on a monthly basis.
- B. To reflect revisions to the schedule, Contractor shall provide City with a written narrative with a full description and reasons for each Work activity revised. For revisions affecting the sequence of work, Contractor shall provide a schedule diagram which compares the original sequence to the revised sequence of work. Contractor shall provide the written narrative and schedule diagram for revisions two (2) calendar days in advance of the monthly schedule update meeting.
- C. Schedule revisions shall not be incorporated into any schedule update until the revisions have been reviewed by City. City may request further information and justification for schedule revisions and Contractor shall, within three (3) calendar days, provide City with a complete written narrative response to City's request.
- D. If Contractor's revision is still not accepted by City, and Contractor disagrees with City's position, Contractor has seven (7) calendar days from receipt of City's letter rejecting the revision, to provide a written narrative providing full justification and explanation for the revision. Contractor's failure to respond in writing within seven (7) calendar days of City's written rejection of a schedule revision shall be contractually interpreted as acceptance of City's position, and Contractor waives its rights to subsequently dispute or file a claim regarding City's position.
- E. At City's discretion, Contractor can be required to provide subcontractor certifications of performance regarding proposed schedule revisions affecting said subcontractors.

1.7 RECOVERY SCHEDULE

- A. If the Schedule Update shows a substantial completion date twenty-one (21) calendar days beyond the Contract Substantial Completion date, or individual milestone completion dates, Contractor shall submit to City the proposed revisions to recover the lost time within seven (7) calendar days. As part of this submittal, Contractor shall provide a written narrative for each revision made to recapture the lost time. If the revisions include sequence changes, Contractor shall provide a schedule diagram comparing the original sequence to the revised sequence of work.
- B. The revisions shall not be incorporated into any schedule update until the revisions have been reviewed by City.
- C. If Contractor's revisions are not accepted by City, City and Contractor shall follow the procedures in paragraph 1.6.C, 1.6.D and 1.6.E above.

- D. At City's discretion, Contractor can be required to provide subcontractor certifications for revisions affecting said subcontractors.

1.8 TIME EXTENSIONS

- A. Contractor is responsible for requesting time extensions for time impacts that, in the opinion of Contractor, impact the critical path of the current schedule update. Notice of time impacts shall be given in accord with [Division 00 – General Conditions, Article 5](#).
- B. Where an event for which City is responsible impacts the projected Substantial Completion date, Contractor shall provide a written mitigation plan, including a schedule diagram, which explains how the impact can be mitigated (e.g., increase crew size, overtime, etc.). Contractor shall also include a detailed cost breakdown of the labor, equipment and material Contractor would expend to mitigate City caused time impact. Contractor shall submit its mitigation plan to City within ten (10) working days from the date of discovery of said impact. Contractor is responsible for the cost to prepare the mitigation plan.
- C. Failure to request time or provide the required mitigation plan will result in Contractor waiving its right to a time extension and cost to mitigate the delay.
- D. No time will be granted under this Contract for cumulative effect of changes.
- E. City will not be obligated to consider any time extension request unless requirements of Contract Documents are satisfied.
- F. Failure of Contractor to perform in accordance with the current schedule update shall not be excused by submittal of time extension requests.

1.9 PROJECT STATUS REPORTING

- A. In addition to submittal requirements for scheduling identified in this Section, Contractor shall provide a monthly project status report (i.e., written narrative report) to be submitted in conjunction with each Schedule as specified herein. Status reporting shall be in form specified below.
- B. Contractor shall prepare monthly written narrative reports of status of Project for submission to City. Written status reports shall include:
 - 1. Status of major Project components (percent complete, amount of time ahead or behind schedule) and an explanation of how Project will be brought back on schedule if delays have occurred.
 - 2. Progress made on critical activities indicated on Schedule, inspections and visits by the Building and/or Special Inspection Inspector.
 - 3. Explanations for any lack of work on critical path activities planned to be performed during last month.
 - 4. Explanations for any schedule changes, including changes to logic or to activity durations.

5. List of critical activities scheduled to be performed next month.
6. Status of major material and equipment procurement.
7. Any delays encountered during reporting period.
8. Contractor shall provide a printed report indicating actual versus planned resource loading for each trade and each activity. This report shall be provided on weekly and monthly basis.
 - a. Actual resource shall be accumulated in field by Contractor, and shall be as noted on Contractor's daily reports. These reports will be basis for information provided in monthly and weekly printed reports.
 - b. Contractor shall explain all variances and mitigation measures.
9. Contractor may include any other information pertinent to status of Project. Contractor shall include additional status information requested by City at no additional cost.
10. Status reports, and the information contained therein, shall not be construed as claims, notice of claims, notice of delay, or requests for changes or compensation.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION 01 32 16

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SECTION 01 33 00 – SUBMITTAL PROCEDURES**PART 1 - GENERAL**

1.1 SUMMARY

- A. This section describes general requirements for submittals for the Work:
1. Procedures
 2. Schedule of Shop Drawing and Sample Submittals
 3. Safety Plan
 4. Progress Schedule
 5. Product Data
 6. Shop drawings
 7. Samples
 8. Quality Control Submittals
 - a. Design Data
 - b. Test Reports
 - c. Certificates
 - d. Manufacturers' Instructions
 9. Machine Inventory Sheets
 10. Operations and Maintenance Manuals
 11. Keys
 12. Project Record Documents
- B. Related Sections:
1. [Division 00 – General Conditions, Article 2](#)
 2. [Section 01 10 00 - Summary](#)
 3. [Section 01 25 00 – Substitution Procedures](#)
 4. [Section 01 26 00 – Contract Modification Procedures](#)
 5. [Section 01 29 00 – Payment Procedures](#)
 6. [Section 01 32 16 – Construction Progress Schedule](#)
 7. [Section 01 78 00 – Closeout Submittals](#)

1.2 PROCEDURES

- A. Upon issuance of the “Notice to Proceed”, the Contractor shall have thirty-five (35) calendar days to submit, at Contractor/Vendor expense, sets of the following: Schedule of Shop Drawing and Sample Submittals, Safety Plans, Progress Schedule, Product Data, Shop Drawings, Samples, Quality Control Data, Machine Inventory Sheets, Operations and Maintenance Manuals, and Project Record Documents required by the Contract Documents. Submit these submittals to Project Manager for review and approval in accordance with accepted schedule of Shop Drawings and Samples submittals.

- B. Transmit each item with a standard letter of transmittal. Identify project, Contractor, subcontractor, major supplier, pertinent drawing sheet and detail number, technical specifications, and specification section number as appropriate. Provide space for Contractor, Project Manager and Architect/Engineer review stamps. Where manufacturer's standard drawings or data sheets are used, they shall be marked clearly to show those portions of the data which are applicable to this project. The transmittal sheet will include the following:
1. Date
 2. Project and Contract Name and Number
 3. Subcontractor or supplier as appropriate
 4. Trade
 5. Contractor Review Stamp
- C. The data shown on the Shop Drawings shall be complete with respect to quantities, dimensions, specified performance and design criteria, materials and similar data to show Project Manager and Architect/Engineer the materials and equipment Contractor proposes to provide and to enable Project Manager and Architect/Engineer to review the information for the limited purposes specified below. Samples shall be identified clearly as to material, supplier; pertinent data such as catalog numbers and the use for which it is intended and otherwise as Project Manager and Architect/Engineer may require enabling Project Manager and Architect/Engineer to review the submittal.
- D. At the time of each submission, Contractor shall give City specific written notice of all variations, if any; that the Shop Drawing or Sample submitted may have from the requirements of the Contract Documents, and the reasons therefore. This written notice shall be a separate document from the submittal. In addition, Contractor shall cause a specific notation to be made on each Shop Drawing and Sample submitted to City for review and approval of each such variation. If City accepts deviation, City shall issue appropriate Contract Modification.
- E. Submittal coordination and verification of contract compliance is responsibility of Contractor; this responsibility shall not be delegated in whole or in part to subcontractors or suppliers. Before submitting each Shop Drawing or Sample, Contractor shall have reviewed and coordinated each Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents, and shall have determined and verified:
1. All field measurements, quantities, dimensions, specified performance criteria, installation requirements, materials, catalog numbers and similar information with respect thereto;
 2. All materials with respect to intended use, fabrication, shipping, handling, storage, assembly and installation pertaining to the performance of the Work; and
 3. All information relative to Contractor's sole responsibilities and of means, methods, techniques, sequences and procedures of construction and safety precautions and programs incident thereto.

- F. Contractor's submission to City of a Shop Drawing or Sample submittal will constitute Contractor's representation that it has satisfied its obligations under the Contract Documents, and as set forth immediately above, with respect to Contractor's review and approval of that submittal.
- G. After review by Project Manager and Architect/Engineer of each of Contractor's submittals, one set of materials will be returned to Contractor with actions defined as follows:
 - 1. NO EXCEPTIONS TAKEN - Accepted subject to its compatibility with future submittals and additional partial submittals for portions of the work not covered in this submittal. Does not constitute approval or deletion of specified or required items not shown on the submittal.
 - 2. MAKE CORRECTIONS NOTED (NO RESUBMISSIONS REQUIRED) - Same as 1. above, except that minor corrections as noted shall be made by Contractor.
 - 3. AMEND AND RESUBMIT - Rejected because of major inconsistencies or errors which shall be resolved or corrected by Contractor prior to subsequent review by Project Manager and Architect/Engineer.
 - 4. REJECTED - RESUBMIT - Submitted material does not conform to Plans and Specifications in major respect, i.e.: wrong size, model, capacity, or material.
- H. It is considered reasonable that Contractor shall make a complete and acceptable submittal at least by second submission. City reserves the right to deduct monies from payments due Contractor to cover additional costs of Project Manager's and Architect/Engineer's review beyond the second submission. Illegible submittals will be rejected and returned to Contractor for resubmission.
- I. Favorable review will not constitute acceptance by City of any responsibility for the accuracy, coordination and completeness of the submittals. Accuracy, coordination, and completeness of Submittals shall be sole responsibility of Contractor, including responsibility to back check comments, corrections, and modifications resulting from City's review which shall be incorporated in design before fabrication. Submittals may be prepared by Contractor, subcontractors, or suppliers, but Contractor shall ascertain that submittals meet requirements of Contract Documents, while conforming to structural space and access conditions at point of installation. Project Manager and Architect/Engineer's review will be only to determine if the items covered by the submittals will, after installation or incorporation in the Work, conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as indicated by the Contract Documents. Favorable review of submittal, method of work, or information regarding materials and equipment Contractor proposes to furnish shall not relieve Contractor of responsibility for errors therein and shall not be regarded as assumption of risks or liability by Architect/Engineer or City, or any officer or employee thereof, and Contractor shall have no claim under Contract on account of failure or partial failure or inefficiency or insufficiency of any plan or method of work or material and equipment so accepted. Favorable review shall be considered to mean merely that Architect/Engineer or City has no objection to

Contractor using, upon his own full responsibility, plan or method of work proposed, or furnishing materials and equipment proposed.

- J. City's review shall not be construed as approval of means, methods, techniques, sequences or procedures of construction or to safety precautions or programs incident thereto. The review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.
- K. Submit complete initial submittal for those items where required by individual technical specifications, or specification sections. Complete submittal shall contain sufficient data to demonstrate that items comply with Specifications, shall meet minimum requirements for submissions cited in technical specifications, shall include motor data and seismic anchorage certifications, where required, and shall include necessary revisions required for equipment other than first named. If Contractor submits incomplete initial submittal, when complete submittal is required, submittal may be returned to Contractor without review.
- L. It shall be Contractor's responsibility to copy, conform and distribute reviewed submittals in sufficient numbers for Contractor's files, subcontractors and vendors.
- M. After Project Manager's and Architect/Engineer's review of submittal, revise and resubmit as required. Identify changes made since previous submittal.
 - 1. Begin no fabrication or work which require submittals until return of submittals not requiring re-submittal.
 - 2. Normally, submittals will be processed and returned to Contractor within fifteen (15) calendar days of receipt.
- N. Distribute copies of reviewed submittals to concerned persons. Instruct recipients to promptly report any inability to comply with provisions.

1.3 SCHEDULE OF SHOP DRAWING AND SAMPLE SUBMITTALS

- A. Submit preliminary Schedule of Shop Drawing and Sample Submittals as required by [Division 00 - General Conditions](#) or as elsewhere specified in the Contract Documents. Submit three (3) copies and PDF of final and accepted schedule of submittals of shop drawings and samples as required by [Division 00 - General Conditions](#), and in no event later than thirty-five (35) calendar days following Notice to Proceed.
- B. Schedule of Shop Drawing and Sample Submittals will be used by Project Manager and Architect/Engineer to schedule their activities relating to review of submittals. Schedule of submittals shall indicate a spreading out of submittals and early submittals of long-lead-time items and of items which require extensive review.
- C. Schedule of Shop Drawing and Sample Submittals shall be reviewed by Project Manager and shall be revised and resubmitted until accepted by Project Manager.

1.4 SAFETY PLAN

- A. Submit three (3) copies of Safety Plan specific to this Contract to Project Manager within fifteen (15) calendar days of issuance of the Notice to Proceed.
- B. One (1) copy of accepted Safety Plan will be returned to Contractor.
- C. No on-site work shall be started until Safety Plan has been reviewed and accepted by City. Acceptance of Safety Plan shall not affect Contractor's responsibility for maintaining a safe working place and instituting safety programs in connection with project.

1.5 PROGRESS SCHEDULE

- A. See [Section 01 32 16 – Construction Progress Schedule](#) for schedule and report requirements.
- B. Submit three (3) copies and PDF of schedule at each of the following times:
 - 1. Initial CPM Schedule at the Preconstruction Conference (covering in detail first thirty (30) calendar days of contract performance, and at a summary level for remainder of contract).
 - 2. Original CPM Schedule within thirty (30) calendar days of the Notice to Proceed date (covering in detail entire Work of Contract to completion).
 - 3. Adjustments to the CPM Schedule as required.
 - 4. CPM Schedule updates weekly, two (2) calendar days prior to weekly progress meeting.
- C. Submit three (3) copies and PDF of the reports listed in [Section 01 32 16 – Construction Progress Schedule](#) with:
 - 1. Initial CPM Schedule
 - 2. Original CPM Schedule
 - 3. Each weekly Schedule update
- D. Progress Schedules and Reports shall be submitted electronically and stored in a USB flash drive in addition to hard copies specified above.

1.6 PRODUCT DATA

- A. Within ten (10) calendar days after Start Date of the Contract Times, submit copies of complete list of major products and equipment proposed for use, with name of manufacturer, trade name, and model number of each product.
- B. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.
- C. Tabulate products by Special Conditions and Specification Section Number.

- D. Supplemental Data: Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturer's standard data to provide information unique to Project.
- E. Provide copies for Project Record Documents described in [Section 01 78 00 – Closeout Submittals](#).

1.7 SHOP DRAWINGS

- A. Submit three (3) copies and PDF of shop drawings.
- B. Minimum Sheet Size: 8-1/2 inches by 11 inches. All others: Multiples of 8-1/2 inches by 11 inches, 22 inches by 34 inches (ANSI D) maximum.
- C. Original sheet or reproducible transparency will be marked with Project Manager's and/or Architect/Engineer's review comments and returned to Contractor.
- D. Mark each copy to identify applicable Products, models, options, and other data; supplement manufacturers' standard data to provide information unique to Work.
- E. Include manufacturers' installation instructions when required by technical specifications or specification section.

1.8 SAMPLES

- A. Submit full range of manufacturers' standard colors, textures, and patterns for Project Manager's selection where not indicated in documents or for substitutions or "equals".
- B. Submit samples to illustrate functional and aesthetic characteristics of Product, with integral parts and attachment devices. Coordinate submittal of different categories for interfacing work.
- C. Include identification on each sample, giving full information.
- D. Submit three (3) samples unless otherwise specified.
- E. Sizes: Unless otherwise specified, provide the following:
 - 1. Paint Chips: Manufacturers' standard.
 - 2. Flat or Sheet Products: Minimum 6 inches square, maximum 12 inches square.
 - 3. Linear Products: Minimum 6 inches, maximum 12 inches long.
 - 4. Bulk Products: Minimum 1 pint, maximum 1 gallon.
- F. Full size samples may be used in Work upon approval.
- G. Mock-ups:

1. Erect field samples and mock-ups at Project site in accordance with requirements of Special Conditions or Specification sections.
2. Modify or make additional field samples and mock-ups as required to provide appearance and finishes approved by Project Manager.
3. Approved field samples and mock-ups may be used in Work upon approval.

1.9 QUALITY CONTROL SUBMITTALS

- A. Design Data: Three (3) copies and PDF.
- B. Test Reports: Three (3) copies and PDF.
 1. Indicate that material or product conforms to or exceeds specified requirements.
 2. Reports may be from recent or previous tests on material or product, but must be acceptable to Project Manager. Comply with requirements of each individual technical specifications or specification Section.
- C. Certificates: Three (3) copies and PDF.
 1. Indicate that material or product conforms to or exceeds specified requirements.
 2. Submit supporting reference data, affidavits, and certifications as appropriate.
 3. Certificates may be recent or from previous test results on material or product, but must be acceptable to Project Manager.
- D. Manufacturers' Instructions: Three (3) copies and PDF.
 1. Include manufacturer's printed instructions for delivery, storage, assembly, installation, startup, adjusting, and finishing.
 2. Identify conflicts between manufacturer's instructions and Contract Documents.

1.10 MACHINE INVENTORY SHEETS

- A. Submit three (3) copies of machine inventory sheets including inventory list for spare parts and materials. If necessary, copies will be marked with Project Manager's and/or Architect/Engineer's review comments and returned to Contractor for correction until satisfactory information is provided. City will retain satisfactorily corrected sheets for its own use.

1.11 OPERATIONS AND MAINTENANCE MANUALS

- A. Submit three (3) copies and PDF of manufacturers' operations and maintenance manuals. If necessary, copies will be marked with City's review comments and returned to Contractor for correction until satisfactory information is provided. City will retain satisfactorily corrected manuals for its own use.
- B. Operations and maintenance manuals shall include the following as appropriate:
 1. Operating instructions.
 2. Preventive maintenance instructions.

3. Cleaning instructions.
 4. Safety precautions.
 5. Trouble shooting procedures.
 6. Theory of operation to discrete component level.
 7. Schematic diagrams, flow diagrams, wiring diagrams, logic diagrams, etc. to discrete component level.
 8. Parts lists showing all discrete components with part number, current prices and availability.
 9. List of replaceable supplies; paper, ink, ribbon, etc. with part numbers, current prices and availability.
 10. Recommended levels of spare parts and supplies to keep on hand.
 11. Manufacturers' service and maintenance technical manuals.
 12. Names, addresses and telephone numbers of service and repair firms for the equipment.
- C. Manuals shall be the same as are used by manufacturers' authorized technicians to completely service and repair the equipment.
- 1.12 KEYS
- A. Submit two (2) complete sets of keys for the Project and all related facilities.
 - B. Submit an inventory list of keys.
- 1.13 PROJECT RECORD DOCUMENTS
- A. Submit copies of each of the Project Record Documents as listed in [Section 01 78 00 – Closeout Submittals](#).

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION 01 33 00

SECTION 01 41 00 – REGULATORY REQUIREMENTS**PART 1 - GENERAL****1.1 SUMMARY**

- A. This section includes some of the key regulatory requirements applicable to Contract, provided for the Contractor's convenience only, and not intended as a complete list of all currently applicable regulatory requirements.

1.2 REFERENCES TO REGULATORY REQUIREMENTS

- A. Codes, laws, ordinances, rules and regulations referred to shall have full force and effect as though printed in full in these specifications.
- B. Conform to referenced codes, laws, ordinances, rules and regulations which are in effect on date of receipt of bids.

1.3 CODES

- A. Codes which apply to Contract include, but are not limited to, the following:
 - 1. California Building Code (CBC) – Latest Edition:
 - a. California Administrative Code: Title 24, Part 1.
 - b. California Building Code: Title 24, Part 2 (Includes the California Historical Building Code, Part 8 and California Existing Building Code, Part 10).
 - c. California Residential Code: Title 24, Part 2.5
 - d. California Electrical Code: Title 24, Part 3.
 - e. California Mechanical Code: Title 24, Part 4.
 - f. California Plumbing Code: Title 24, Part 5.
 - g. California Energy Code: Title 24, Part 6.
 - h. California Fire Code: Title 24, Part 9.
 - i. California Green Building Standards Code (CALGreen): Title 24, Part 11.
 - j. California Referenced Standards Code: Title 24, Part 12.

1.4 LAWS, ORDINANCES, RULES AND REGULATIONS

- A. During prosecution of Work to be done under Contract, comply with applicable laws, ordinances, rules and regulations, including, but not limited to, the following:
 - 1. Federal/National:
 - a. Americans with Disabilities Act (ADA): Latest edition; Civil Rights Division, Office on the Americans with Disabilities Act, U.S. Department of Justice

- b. National Fire Protection Association (NFPA): Life Safety Code - NFPA 101.
 - c. U. S. Environmental Protection Agency (EPA): Laws and regulations.
 - d. 29 CFR, Section 1910.1001, Asbestos
 - e. 40 CFR, Subpart M, National Emission Standards for Asbestos
 - f. Executive Order 11246
2. State of California:
- a. California Code of Regulations, Titles 5, 8, 19, 21, 24
 - b. California Education Code
 - c. California Public Contract Code
 - d. California Health and Safety Code
 - e. California Government Code
 - f. California Labor Code
 - g. California Civil Code
 - h. California Code of Civil Procedure
 - i. CPUC General Order 95, Rules for Overhead Electric Line Construction
 - j. CPUC General Order 128, Rules for Construction of Underground Electric Supply and Communications Systems
3. State of California Agencies:
- a. State and Consumer Services Agency
 - b. Department of Industrial Relations – Public Works
 - c. Office of the State Fire Marshal
 - d. California Environmental Protection Agency (CalEPA): State regulations and standards.
 - e. California Integrated Waste Management Board:
 - 1) General: Sustainable Building Guidelines.
 - 2) Construction Waste Management: Construction and Demolition Debris Recycling.
 - f. California State Water Resources Control Board (SWRCB): SWPPP Standards.
 - g. California Department of Toxic Substances Control (DTSC): Hazardous Waste Management standards.
4. City Codes:
- a. Pittsburg Municipal Code
5. Local Agencies:
- a. Bay Area Air Quality Management
 - b. County of Contra Costa
 - c. City of Pittsburg

1.5 RESERVED

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION 01 41 00

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SECTION 01 42 00 – REFERENCES**PART 1 - GENERAL****1.1 SUMMARY****A. Section Includes:**

1. This section includes reference standards, symbols and definitions used in Contract Documents.
2. Material and workmanship specified by reference to number, symbol, or title of specific standard such as state standard, commercial standard, federal specifications, technical society, or trade association standard, or other similar standard shall comply with requirements of standards except when more rigid requirements are specified or required by applicable codes.
3. Standards referred to, except as modified herein, shall have full force and effect as though printed in the Contract Documents. Standards are not furnished to Contractor, since manufacturers and trades involved are assumed to be familiar with their requirements.

1.2 REFERENCE TO STANDARDS AND SPECIFICATIONS OF TECHNICAL SOCIETIES; REPORTING AND RESOLVING DISCREPANCIES:

- A. Latest in Effect: Reference to standards, specifications, manuals or codes of any technical society, organization or association, or to the laws or regulations of any governmental authority, whether such reference be specific or by implication, shall mean the latest standard, specification, manual, code or laws or regulations in effect at the time of opening of Bids, except as may be otherwise specifically stated in the Contract Documents.
- B. Discrepancies: If during the performance of the Work, Contractor discovers any conflict, error, ambiguity or discrepancy within the Contract Documents or between the Contract Documents and any provision of any such law or regulation applicable to the performance of the Work or of any such standard, specification, manual or code or of any instruction of any supplier, Contractor shall report it in writing at once to Inspector, with copies to Project Manager and Architect/Engineer, and Contractor shall not proceed with the Work affected thereby until consent to do so is given by Project Manager.
- C. Precedence: Except as otherwise specifically stated in the Contract Documents, including Division 00 – General Conditions, Article 3, or as may be provided by Change Order, or supplemental instruction, the provisions of the Contract Documents shall take precedence in resolving any conflict, error, ambiguity or discrepancy between the provisions of the Contract Documents and:

1. The provisions of any such standard, specification, manual, code, or instruction (whether or not specifically incorporated by reference in the Contract Documents); or
2. The provisions of any such laws or regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such law or regulation).
3. No provision of any such standard, specification, manual, code or instruction shall be effective to change the duties and responsibilities of City, Contractor, Project Manager, or Architect/Engineer, or any of their subcontractors, consultants, agents, or employees, from those set forth in the Contract Documents, nor shall it be effective to assign to City, Architect/Engineer, Project Manager, or any of their consultants, agents or employees any duty or authority to supervise or direct the furnishing or performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of the Contract Documents.

1.3 STANDARDS

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AI	The Asphalt Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
ANSI	American National Standards Institute, Inc.
APA	American Plywood Association
APWA	American Public Works Association
AREMA	The American Railway Engineering and Maintenance-of-Way Association
ASCE	American Society of Civil Engineers
ASLA	American Society of Landscape Architects
ASME	American Society of Mechanical Engineers

ASSE	American Society of Sanitary Engineering
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
BASMAA	Bay Area Stormwater Management Agencies Association
BBC	Basic Building Code, Building Officials and Code Administrators International
BFL	Bay Friendly Landscaping
CALOSHA	California Occupational Safety and Health Administration
CA MUTCD	California Manual on Uniform Traffic Control Devices
CALTRANS	State of California Department of Transportation
CBC	California Building Code
CCR	California Code of Regulations
CLFMI	Chain Link Fence Manufacturer's Institute
CRSI	Concrete Reinforcing Steel Institute
DDW	Division of Drinking Water
EIA	Electronic Industries Association
IAPMO	International Association of Plumbing and Mechanical Officials
ICBO	International Conference of Building Officials
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
ITE	Institute of Traffic Engineers
MSS	Manufacturers Standardization Society
NACE	National Association of Corrosion Engineers
NBS	National Bureau of Standards
NEC	National Electrical Code

NEMA	National Electrical Manufacturer's Association
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration (Federal)
PCA	Portland Cement Association
PUC	Public Utilities Commission
SSPC	Steel Structures Painting Council
STA	Seal of Testing Assurance Program
UL	Underwriters Laboratories, Inc
USCC	U S Composting Council

1.4 SYMBOLS

- A. Symbols, used only on Drawings, are shown thereon.

1.5 DEFINITIONS

- A. Wherever any of the words or phrases defined below, or a pronoun used in place thereof, is used in any part of the City Standard Specifications, it shall have the meaning here set forth:
1. ADDENDUM/ADDENDA: Written or graphic instruments issued prior to the opening of Bids which clarify, correct or change the bidding requirements or the Contract Documents.
 2. ADDITIVE BID: The sum to be added to the Base Bid if the change in scope of work as described in Additive Bid is accepted by City.
 3. AGREEMENT The Contract executed by the parties as further defined in Division 00 – General Conditions, Article 1.
 4. ALTERNATE: Work added to or deducted from the Base Bid, if accepted by City.
 5. APPROVED EQUAL: Approved in writing by City as being of equivalent quality, utility and appearance.
 6. ARCHITECT/ENGINEER:
 - a. Design Architect: The person holding a valid California State Architect's or Landscape Architect's license, whose firm has been designated within the Contract Documents to provide architectural or landscape architectural services on the project, and who may have engaged engineering subconsultants to provide services on Project.
 - b. Design Engineer: The person holding a valid California State Engineering license, whose firm has been designated within the Contract Documents to provide civil, structural, traffic or other

- engineering services on the project, and who may have engaged engineering subconsultants to provide services on Project.
- c. When the Architect/Engineer is referred to within the Contract Documents and no Architect or Engineer has in fact been designated, then the matter shall be referred to City. The term Architect/Engineer shall be construed to include all his or her consultants retained for the Project, as well as employees of the Architect/Engineer. When the designated Architect/Engineer is an employee of City, his or her authorized representatives on the Project within the district will be included under the term Architect/Engineer.
7. AS-BUILTS: Project Record Documents as required by the General Conditions and [Section 01 78 00 – Closeout Submittals](#).
 8. BID: The offer or proposal of the Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.
 9. BIDDER: One who submits a Bid.
 10. BY CITY: Work that will be performed by City or its agents at the City's expense.
 11. BY OTHERS: Work that is outside scope of Work to be performed by Contractor under this Contract, which will be performed by City, other contractors, or other means.
 12. CITY: City of Pittsburg, acting through its City Council or any of its authorized agents.
 13. CITY CORPORATION YARD: Located at 357 East 12th Street, Pittsburg, CA 94565-2628.
 14. CITY ENGINEER: City employee in charge of Engineering.
 15. CITY-FURNISHED, CONTRACTOR-INSTALLED: Items furnished by City at its cost for installation by Contractor at its cost under this Contract.
 16. CITY'S PROJECT MANAGER(S): The person or persons assigned by City to be City's agent(s) or representative(s) at the site. City's authorized agent representing City on all matters of the Contract. Project Manager may authorize agents and representatives to act in carrying out Project Manager's duties, including a "Construction Manager", to act under the authority of the Project Manager. As City's agent, the Project Manager is the beneficiary of all contract obligations of Contractor to City, including without limitation, all releases and indemnities.
 17. CHANGE ORDER: A written instrument prepared by City and signed by City and Contractor, stating their agreement upon all of the following:
 - a. a change in the Work,
 - b. the amount of the adjustment in the Contract Sum, if any, and
 - c. the amount of the adjustment in the Contract Time, if any.
 18. CONCEALED: Work not exposed to view in the finished Work, including within or behind various construction elements.
 19. CONTRACT CONDITIONS: Conditions of the Contract define basic rights, responsibilities and relationships of Contractor and City and consists of two parts: General Conditions and Supplementary Conditions.

- a. General Conditions are general clauses which are common to the City Contracts.
- b. Supplementary conditions modify or supplement General Conditions to meet specific requirements for this Contract.
20. CONTRACT DOCUMENTS: Contract Documents shall consist of the documents identified as the Contract Documents in [Division 00 - General Conditions, Article 1](#), plus all changes, addenda and modifications thereto.
21. CONTRACT MODIFICATION: Either:
 - a. a written amendment to Contract signed by Contractor and City; or
 - b. a Change Order; or
 - c. a written directive for a minor change in the Work issued by City.
22. CONTRACT SUM: The sum stated in the Agreement and, including authorized adjustments, the total amount payable by City to Contractor for performance of the Work and the Contract Documents. The Contract Sum is also referred to as the Contract Price or the Contract Amount.
23. CONTRACT TIMES or CONTRACT TIME: The number or numbers of days or the dates stated in the Agreement (i) to achieve substantial completion of the Work or designated milestones and/or (ii) to complete the Work so that it is ready for final payment and is accepted.
24. CONSTRUCTION MANAGER: A representative of City with authority to act on behalf of City, as specified by City or Project Manager.
25. CONTRACTOR: The person or entity identified as such in the Agreement and referred to throughout the Contract Documents as if singular in number and neuter in gender. The term "Contractor" means the Contractor or its authorized representative.
26. CONTRACTOR'S EMPLOYEES: Persons engaged in execution of Work under Contract as direct employees of Contractor, as subcontractors, or as employees of subcontractors.
27. DATE OF SUBSTANTIAL COMPLETION: Date of Substantial Completion of Work or designated portion thereof is date certified by Project Manager when construction is sufficiently complete in accordance with Contract Documents for City to occupy Work or designated portion thereof and have beneficial use of it for the purposes intended.
28. DAY: One calendar day, unless the word "day" is specifically modified to the contrary.
29. DEFECTIVE: An adjective which, when modifying the word "Work", refers to Work that is unsatisfactory or unsuited for the use intended, faulty, or deficient, that it does not conform to the Contract Documents, or does not meet the requirements of any inspection, reference standard, test or approval referred to in the Contract Documents (including but not limited to approval of samples and "or equal" items), or has been damaged prior to final payment (unless responsibility for the protection thereof has been assumed by City). Project Manager is the judge of whether Work is defective.
30. DRAWINGS: The graphic and pictorial portions of Contract Documents, wherever located and whenever issued, showing the design, location and

- dimensions of the Work, generally including plans, elevations, sections, details, schedules and diagrams.
31. EQUAL: Equal in opinion of Project Manager. Burden of proof of equality is responsibility of Contractor.
 32. EXPOSED: Work exposed to view in the finished Work, including behind louvers, grilles, registers and various other construction elements.
 33. FINAL ACCEPTANCE or FINAL COMPLETION: City's acceptance of the Work as satisfactorily completed in accordance with Contract Documents. Requirements for Final Acceptance/Final Completion include, but are not limited to:
 - a. All Systems having been tested and accepted as having met requirements of Contract Documents.
 - b. All required instructions and training sessions having been given by Contractor.
 - c. All as-built drawings, operations and maintenance manuals, and other closeout submittals having been submitted by Contractor, and reviewed and accepted by City.
 - d. All punch list work, as directed by City, having been completed by Contractor.
 - e. All Work, except Contractor maintenance after Final Acceptance, having been completed to satisfaction of City.
 - f. See [Section 01 29 00 – Payment Procedures](#), 1.9.D regarding Final Payment.
 - g. See [Section 01 77 00 – Closeout Requirements](#).
 34. FORCE ACCOUNT: Work directed to be performed without prior agreement as to lump sum or unit price cost thereof, and which is to be billed at cost for labor, materials, equipment, taxes, and other costs, plus a specified percentage for overhead and profit.
 35. FURNISH: Supply and deliver to the jobsite.
 36. INDICATED: Shown or noted on the Drawings.
 37. INSPECTOR: The person engaged by City to inspect the workmanship, materials, or manner of construction of buildings or portions of buildings, to determine if such construction complies with the Contract Documents and applicable codes.
 38. INSTALL: Anchor, fasten, or connect in place and adjust for use; place or apply in proper position and location; establish in place for use or service.
 39. LATENT: Not apparent by reasonable inspection, including but not limited to, the inspections and research required as a condition to bidding under the General Conditions.
 40. MATERIAL OR MATERIALS: These words shall be construed to embrace machinery, manufactured articles, materials of construction (fabricated or otherwise), and any other classes of material to be furnished in connection with Contract, except where a more limited meaning is indicated by context.
 41. MILESTONE: A principal event specified in Contract Documents relating to an intermediate completion date or time prior to Substantial Completion of all Work.

42. MODIFICATION: Same as Contract Modification.
43. NOT IN CONTRACT: Work that is outside the scope of work to be performed by Contractor under this Contract.
44. NOTICE OF AWARD: A written notice given by City to lowest responsive, responsible bidder advising that Bidder's bid and other qualifying information is acceptable to City, requiring Bidder to fulfill the requirements of Article 4 of [Division 00 - General Conditions](#).
45. NOTICE TO PROCEED: A written notice given by City to Contractor fixing the date on which the Contract Time will commence to run and on which contractor shall start to perform Contractor's obligations under the Contract Documents.
46. OFF SITE: Outside geographical location of the Project.
47. OWNER: City of Pittsburg, acting through its officers, employees, or its authorized agent.
48. PROGRESS REPORT: A periodic report submitted by Contractor to City with progress payment invoices accompanying actual work accomplished to the Program Schedule. See [Section 01 32 16 - Construction Progress Schedule](#) and Reports required in [Division 00 - General Conditions](#).
49. PROJECT: Total construction of which Work performed under this Contract may be whole or part.
50. PROJECT MANUAL: Project Manual consists of Bidding Requirements, Agreement, Bonds, Certificates, Contract Conditions, Technical Specifications, and Specifications.
51. PROVIDE: Furnish and install.
52. REQUESTS FOR INTERPRETATION ("RFI"): A document prepared by Contractor requesting interpretation, information, and/or clarification regarding the Project or Contract Documents.
53. SAMPLES: Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and which establish the standards by which such portion of the Work will be judged.
54. SHOP DRAWINGS: All drawings, diagrams, illustrations, schedules and other data or information which are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the work.
55. SITE/JOBSITE: The particular geographical location of Work performed pursuant to Contract.
56. TECHNICAL SPECIFICATIONS: Divisions 01 through 34 – Technical Specifications, which states project-specific requirements.
57. SPECIFICATIONS: The written portion of the Contract Documents consisting of requirements for materials, equipment, construction systems, standards and workmanship for the Work, and performance of related services; and are contained in Divisions 01 through 48.
58. SPECIFIED: As written in Technical Specifications and Specifications.
59. SUBCONTRACTOR: A person or entity who has a direct contract with Contractor to perform a portion of the Work at the site. The term "subcontractor" is referred to throughout the Contract Documents as if

singular in number and neuter in gender and means a subcontractor or an authorized representative of the subcontractor. The term "subcontractor" does not include a separate contractor or subcontractors of a separate contractor.

60. SUBMITTALS: Shop drawings, samples and other items specified in [Section 01 33 00 - Submittal Procedures](#).
 61. SUBSTANTIAL COMPLETION: The Work (or a specified part thereof) has progressed to the point where, in the opinion of the Project Manager and Architect/Engineer and as evidenced by a Certificate of Substantial Completion, the Work is sufficiently complete, in accordance with Contract Documents, so that the Work (or specified part) can be utilized for the purposes for which it is intended; or if no such certificate is issued, when the Work is complete and ready for final payment as evidenced by written recommendation of Project Manager and/or Architect/Engineer for final payment. The terms "substantially complete" and "substantially completed" as applied to all or part of the Work refer to Substantial Completion thereof. See [Section 01 29 00 – Payment Procedures](#), 1.8.A.2 regarding application for payment of Substantial Completion and [Section 01 77 00 – Closeout Requirements](#).
 62. SUPPLEMENTAL INSTRUCTION: A written work change directive to Contractor from Project Manager or Architect/Engineer, approved by Project Manager, ordering alterations or modifications which do not result in change in Contract Sum or Contract Times, and do not substantially change Drawings, Technical Specifications, or Specifications.
 63. UNDERGROUND FACILITIES: All pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels or other such facilities or attachments, and any encasements containing such facilities which have been installed underground to furnish any of the following services or materials: Electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, sewage and drainage removal, traffic or other control systems or water.
 64. WORK: The entire completed construction or the various separately identifiable parts thereof required to be furnished under the Contract Documents within the Contract Time. Work includes and is the result of performing or furnishing labor and furnishing and incorporating materials and equipment into the construction, and performing or furnishing services and furnishing documents, all as required by the Contract Documents including the Drawings, Technical Specifications, and Specifications. Wherever the word "work" is used, rather than the word "Work", it shall be understood to have its ordinary and customary meaning.
 65. WORKING DAY. A working day is defined as any day, except as follows:
 - a. Saturdays, Sundays, and legal holidays
 - b. Days on which the Contractor is prevented from performing work by inclement weather or conditions resulting therefrom.
- B. Wherever words "as directed", "as required", "as permitted", or words of like effect are used, it shall be understood that direction, requirements, or permission of City

or Project Manager is intended. Words "sufficient", "necessary", "proper", and the like shall mean sufficient, necessary or proper in judgment of City or Project Manager. Words "approved", "acceptable", "satisfactory", or words of like import, shall mean approved by, or acceptable to, or satisfactory to, City or Project Manager.

- C. Wherever the word "may" is used, the action to which it refers is discretionary. Wherever the word "shall" is used, the action to which it refers is mandatory. Where a colon (:) is used within sentences or phrases, the words "shall" or "shall be" are included by inference. Such imperative statements in the specifications are directed to the Contractor, who has overall responsibility for the subcontractors.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION 01 42 00

SECTION 01 42 13 - ABBREVIATIONS**PART 1 - GENERAL**

1.1 GENERAL

- A. Wherever in these Specifications references are made to the Standards, Specifications or other published data of the various national, regional, or local organizations, such organization may be referred to by their acronym or abbreviation only. As a guide to the use of these Specifications, the following acronyms or abbreviations which may appear in these Specifications shall have the meaning indicated herein.

1.2 ABBREVIATIONS AND ACRONYMS

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AGC	Associated General Contractors
AI	The Asphalt Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
ANSI	American National Standards Institute, Inc.
APA	American Plywood Association
APWA	American Public Works Association
AREMA	The American Railway Engineering and Maintenance-of-Way Association
ASCE	American Society of Civil Engineers
ASLA	American Society of Landscape Architects

ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineering
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
BASMAA	Bay Area Stormwater Management Agencies Association
BBC	Basic Building Code, Building Officials and Code Administrators International
BFL	Bay Friendly Landscaping
CALOSHA	California Occupational Safety and Health Administration
CA MUTCD	California Manual on Uniform Traffic Control Devices
CALTRANS	State of California Department of Transportation
CBC	California Building Code
CCR	California Code of Regulations
CFC	California Fire Code
CLFMI	Chain Link Fence Manufacturer's Institute
CPC	California Plumbing Code
CRSI	Concrete Reinforcing Steel Institute
CVC	California Vehicle Code
DBE	Disadvantaged Business Enterprise
DDW	Division of Drinking Water
EIA	Electronic Industries Association
ICBO	International Conference of Building Officials
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
ITE	Institute of Traffic Engineers

MSS	Manufacturers Standardization Society
NACE	National Association of Corrosion Engineers
NBS	National Bureau of Standards
NEC	National Electrical Code
NEMA	National Electrical Manufacturer's Association
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration (Federal)
PCA	Portland Cement Association
PUC	Public Utilities Commission
SSPC	Steel Structures Painting Council
STA	Seal of Testing Assurance Program
UL	Underwriters Laboratories, Inc
USCC	U S Composting Council

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION 01 42 13

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SECTION 01 43 00 – QUALITY ASSURANCE

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes administrative and procedural requirements for quality assurance.
 - 1. Workmanship: Quality of work.
 - 2. Tolerances: Finished surfaces.
- B. References:
 - 1. General: Refer to [Division 00 - General Conditions](#) and [Section 01 42 00 - References](#). Products or workmanship specified in the Project Manual by association, trade, or other consensus standards shall conform to the requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
 - 2. Contractual Relationship: The contractual duties and responsibilities of the parties of the Contract and those of the Project Manager shall not be altered from the requirements of the Contract Documents by any statement or inference in any reference document.
- C. Testing: Refer to [Section 01 45 00 – Quality Control](#).

PART 2 - PRODUCTS

- 2.1 Refer to [Section 01 60 00 – Product Requirements](#); assure a consistent quality of products furnished by suppliers and manufacturers as indicated throughout the Project Manual.

PART 3 - EXECUTION

3.1 PERFORMANCE

- A. Refer to [Section 01 70 00 – Execution](#).
- B. Workmanship: Perform shop and field work with mechanics, craftspersons, artisans, and workers skilled and experienced in the fabrication and installation of work specified. Install and erect work plumb, level, square, and true, or true to indicated angle, and in proper alignment and relationship to other work. Finished work shall be free from defects and damage. Quality of work shall conform to the highest established standards and practices of the various trades required. The Project Manager reserves the right to reject materials and work quality which

does not meet accepted standards. Repair or replace substandard material or work as directed, at no additional cost to the City.

3.2 INSTALLATION

- A. General: Conduct quality control in concert with suppliers, products, services, site conditions, and workmanship, to produce work of specified quality.
- B. Manufacturer's Instructions:
 - 1. General: Follow manufacturer's instructions, including each step in progression of installation. If manufacturer's instructions conflict with Contract Documents, request clarification from Project Manager before commencing Work.
 - 2. Installer: Manufacturer approved, as required in the technical sections of the Project Manual.
 - 3. Field Services: Coordinate with manufacturer of a product, system, or assembly which requires special knowledge and skill for proper application/installation of the product, system, or assembly to obtain field service, consultation and inspection as required for the application/installation work at no additional cost to the City.
- C. Reference Standards: Conform to specified standards as minimum quality for the Work except where more stringent codes or specified requirements indicate higher standards or more precise workmanship.
- D. Anchorage: Secure products in place with positive anchorage devices designed and sized to withstand stress, vibration, physical distortion, or disfigurement.
- E. Tolerances: Adjust products to appropriate dimensions; position before securing in place. Monitor and control tolerances of installed products to produce acceptable Work.

END OF SECTION 01 43 00

SECTION 01 45 00 – QUALITY CONTROL**PART 1 - GENERAL**

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for quality-control services.
- B. Quality-control services include inspections, tests, and related actions, including reports performed by Contractor, by independent agencies, and by governing authorities. They do not include contract enforcement activities performed by Owner.
- C. Inspection and testing services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with Contract Document requirements.
- D. Requirements of this Section relate to customized fabrication and installation procedures, not production of standard products.
- E. Specific quality-control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products. Refer to the following:
 - 1. [Section 03 30 00 – Utility Cast-in-place Concrete](#) - 3.9 Field Quality Control
 - 2. [Section 03 60 00 – Grouting](#) - 3.4 Field Quality Control
 - 3. [Section 31 05 13 – Clearing & Grubbing, Excavation, and Earthwork](#) – 2.5 – Source Quality Control.
 - 4. [Section 31 23 16 – Utility Trenching](#) - 3.17 Field Quality Control
 - 5. [Section 32 11 23 – Aggregate Base Courses](#) – 3.5 Field Quality Control
 - 6. [Section 32 12 16 – Asphalt Paving](#) – 1.5 Quality Control Plan & 3.13 – Field Quality Control
 - 7. [Section 32 12 17 – Asphalt Paving Rehabilitation](#) – 1.5 Quality Control Plan & 3.17 – Field Quality Control
 - 8. [Section 32 13 13 – Concrete Surface Improvements](#) – 3.5 Field Quality Control
 - 9. [Section 32 17 26 – Detectable Warning Surfacing](#) – 3.4 Field Quality Control
 - 10. [Section 33 01 30 – Testing for Sanitary Sewer, Storm Drainage – Piping and Manholes](#) – 3.3 Field Quality Control
 - 11. [Section 33 05 13 – Manholes and Structures](#) – 3.4 Field Quality Control
 - 12. [Section 33 05 17 – Precast Concrete Valve Vaults and Meter Boxes](#) – 3.4 Field Quality Control
 - 13. [Section 33 11 13 – Water Distribution Piping](#) – 3.6 Field Quality Control
 - 14. [Section 33 12 00 – Water Distribution Equipment](#) – 3.4 Field Quality Control
 - 15. [Section 33 12 13 – Water Service Connections](#) – 3.4 Field Quality Control

16. [Section 33 12 16 – Water Distribution Valves](#) – 3.4 Field Quality Control
17. [Section 33 12 19 – Water Distribution Fire Hydrants](#) – 3.4 Field Quality Control
18. [Section 33 13 00 –Disinfecting of Water Distribution](#) – 3.3 Field Quality Control
19. [Section 33 31 13 – Sanitary Sewer Piping](#) – 3.4 Field Quality Control
20. [Section 33 41 13 – Storm Drainage Piping](#) – 3.5 Field Quality Control

- F. Specified inspections, tests, and related actions do not limit Contractor's quality-control procedures that facilitate compliance with Contract Document requirements.
- G. Requirements for Contractor to provide quality-control services required by Owner, or authorities having jurisdiction are not limited by provisions of this Section.

1.2 RESPONSIBILITIES

- A. Owner's Responsibilities: Unless otherwise indicated as the responsibility of another identified entity, the Owner shall provide inspections, tests, and other quality-control services specified elsewhere in the Contract Documents and required by authorities having jurisdiction.
- B. Where individual Sections specifically indicate that certain inspections, tests, and other quality-control services are the Contractor's responsibility, the Contractor shall employ and pay a qualified independent testing agency to perform quality-control services. Costs for these services are included in the Contract Sum.'
- C. Where the Owner has engaged a testing agency for testing and inspecting part of the Work, and the Contractor is also required to engage an entity for the same or related element, the Contractor shall not employ the entity engaged by the Owner, unless agreed to in writing by the Owner.
- D. Retesting: The Contractor is responsible for retesting where results of inspections, tests, or other quality-control services prove unsatisfactory and indicate noncompliance with Contract Document requirements, regardless of whether the original test was Contractor's responsibility. Refer to [Division 00 - General Conditions, Section 7.8](#).
1. The cost of retesting construction, revised or replaced by the Contractor, is the Contractor's responsibility and will be at no cost to the Owner where required tests performed on original construction indicated noncompliance with Contract Document requirements.
- E. Associated Services: Cooperate with agencies performing required inspections, tests, and similar services, and provide reasonable auxiliary services as requested. Notify the agency sufficiently in advance of operations to permit assignment of personnel. Auxiliary services required include, but are not limited to, the following:

1. Provide access to the Work.
 2. Furnish incidental labor and facilities necessary to facilitate inspections and tests.
 3. Take adequate quantities of representative samples of materials that require testing or assist the agency in taking samples.
 4. Provide facilities for storage and curing of test samples.
 5. Deliver samples to testing laboratories.
 6. Provide the agency with a preliminary design mix proposed for use for materials mixes that require control by the testing agency.
 7. Provide security and protection of samples and test equipment at the Project Site.
- F. Duties of the Owner: Owner will retain a qualified independent agency to perform inspections, sampling, and testing of materials and construction specified in individual Sections.
1. Upon receipt of notice from the testing agency, Owner will notify the Contractor promptly of irregularities or deficiencies identified in the testing Work performance.
 2. The agency is not authorized to release, revoke, alter, or enlarge requirements of the Contract Documents or approve or accept any portion of the Work.
 3. The agency shall not perform any duties of the Contractor.

1.3 SUBMITTALS

- A. Unless the Contractor is responsible for this service, the independent testing agency shall submit a certified written report, in duplicate, of each inspection, test, or similar service to the Owner. If the Contractor is responsible for the service, submit a certified written report, in duplicate, of each inspection, test, or similar service through the Contractor.
1. Submit additional copies of each written report directly to the governing authority, when the authority so directs.
 2. Report Data: Written reports of each inspection, test, or similar service include, but are not limited to, the following:
 - a. Date of issue.
 - b. Project title and number.
 - c. Name, address, and telephone number of testing agency.
 - d. Dates and locations of samples and tests or inspections.
 - e. Names of individuals making the inspection or test.
 - f. Designation of the Work and test method.
 - g. Identification of product and Special Conditions/Specification Section.
 - h. Complete inspection or test data.
 - i. Test results and an interpretation of test results.
 - j. Ambient conditions at the time of sample taking and testing.
 - k. Comments or professional opinion on whether inspected or tested Work complies with Contract Document requirements.

- l. Name and signature of laboratory inspector.
- m. Recommendations on retesting.

1.4 QUALITY ASSURANCE

- A. Qualifications for Service Agencies: Owner will engage inspection and testing service agencies, including independent testing laboratories, that are prequalified as complying with the American Council of Independent Laboratories' "Recommended Requirements for Independent Laboratory Qualification" and that specialize in the types of inspections and tests to be performed.
 - 1. Each independent inspection and testing agency engaged on the Project shall be authorized by (authorities having jurisdiction) to operate in the state where the Project is located.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 REPAIR AND PROTECTION

- A. General: Upon completion of inspection, testing, sample taking and similar services, repair damaged construction and restore substrates and finishes. Comply with Contract Document requirements for [Section 01 70 00 - Execution](#).
- B. Protect construction exposed by or for quality-control service activities, and protect repaired construction.

END OF SECTION 01 45 00

SECTION 01 50 00 – TEMPORARY FACILITIES AND CONTROLS**PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes requirements for installation and removal of temporary facilities and controls, including temporary utilities, support facilities, and security and protection. See also, Division 00 – General Conditions, Article 7, including Sections 7.2, 7.4, and 7.9.
- B. Temporary utilities include, but are not limited to, the following:
 - 1. Water service and distribution.
 - 2. Temporary electric power and light.
 - 3. Temporary heat.
 - 4. Ventilation.
 - 5. Sanitary facilities, including drinking water.
 - 6. Fire protection water service.
- C. Support facilities include, but are not limited to, the following:
 - 1. Temporary enclosures.
 - 2. Temporary project identification signs and bulletin boards.
 - 3. Waste disposal services.
 - 4. Rodent and pest control.
 - 5. Signs.
- D. Security and protection facilities include, but are not limited to, the following:
 - 1. Barricades, warning signs, and lights.
 - 2. Sidewalk bridge or enclosure fence for the site.
 - 3. Environmental protection.

1.2 SUBMITTALS

- A. Temporary Utilities: Submit reports of tests, inspections, meter readings, and similar procedures performed on temporary utilities.
- B. Implementation and Termination Schedule: Within ten (10) working days of the date established for commencement of the Work, submit a schedule indicating implementation and termination of each temporary utility.
- C. Temporary Facilities Plan: Within ten (10) working days prior to scheduled installation of any temporary facility, submit a plan to the Project Manager for review and approval.

1.3 TEMPORARY FACILITIES

- A. Temporary Structures: Obtain permits for, install and maintain in safe condition, whatever scaffolds, hoisting equipment, barricades, walkways, or other temporary structures which may be required to accomplish the work on the Project. Such structures shall be adequate for the intended use and capable of safely accepting all loads that may be imposed upon them. They shall be installed and maintained in accordance with all applicable State and local codes and regulations.
- B. Temporary Heat: Provide and maintain temporary heat from an approved source whenever in the course of the Work it may become necessary for curing and drying of materials, or to warm spaces as may be required for the installation of materials or finishes.
- C. Dewatering: Provide and maintain facilities that may be required for dewatering in order that work may proceed on the Project. If it is necessary for dewatering to occur continually, have on hand whatever spare parts or equipment that may be required to prevent interruption of dewatering. If required, obtain Dewatering Permit from Delta Diablo (Sewer District) for waste discharge.
- D. Temporary Utilities: Provide and maintain all utility services necessary to perform the work under this Contract. These may include, but are not limited to, temporary electricity, water, gas, sewer and telephone, including charges and installation fees. Furnish and maintain all means of distribution of utility services required within the site to properly complete the Project.
- E. Storage: Store materials, tools, accessories, etc., only where directed by City. Keep storage area neat and clean. Security of stored items is Contractor's responsibility.
- F. Flammable Materials: When flammable materials are stored on site, take extra precautions, including clear identification.
- G. Sanitary Facilities: Provide and maintain temporary toilets and wash facilities in quantities and locations as required by CAL/OSHA and other local codes and regulations. Keep them maintained and supplied in a usable and sanitary condition at all times.
- H. Drinking Water: Provide and maintain adequate potable water stations at site until final completion of the Project.
- I. Field Office: If required by the Special Conditions, maintain an office at the Project site which will be the Contractor's headquarters for the Project. Any communications delivered to this office shall be considered as delivered to Contractor. Location and size of office shall be such that it will adequately serve

the needs of Contractor's superintendent and assistants in the performance of their duties.

- J. Removal of Temporary Facilities: Promptly remove temporary facilities when they are no longer needed for the work or for completion of the Project, mutually agreed upon by Contractor and City.
- K. Fire Hydrant: Provide site access and operational fire hydrant prior to any combustible construction on site. Fire hydrants to be relocated shall remain operational until the replacement fire hydrant is operational.

1.4 QUALITY ASSURANCE

- A. Regulations: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction including, but not limited to, the following:
 - 1. Building code requirements.
 - 2. Health and safety regulations.
 - 3. Utility company regulations.
 - 4. Police, fire department, and rescue squad rules.
 - 5. Environmental protection regulations.
- B. Standards: Comply with the following:
 - 1. NFPA 241 "Standard for Safeguarding Construction, Alterations, and Demolition Operations,"
 - 2. ANSI A10 Series standards for "Safety Requirements for Construction and Demolition," and
 - 3. NECA Electrical Design Library "Temporary Electrical Facilities."
- C. Electrical Service:
 - 1. Comply with NEMA, NECA, and UL standards and regulations for temporary electric service.
 - 2. Install service in compliance with NFPA 70 "National Electric Code" and PG&E Green Book, latest edition.
- D. Inspections: Arrange for authorities having jurisdiction to inspect and test each temporary utility before use. Obtain required certifications and permits.

1.5 SIGNS

- A. No signs may be displayed on or about City's property (except those required by law) without City's specific approval; the size, content, and location to be as specified by City.

1.6 PROJECT CONDITIONS

- A. Temporary Utilities: Prepare a schedule indicating dates for implementation and termination of each temporary utility. At the earliest feasible time, when acceptable to the Owner, change over from use of temporary service to use of permanent service.
- B. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Relocate temporary services and facilities as the Work progresses. Do not overload facilities or permit them to interfere with progress. Take necessary fire-prevention measures. Do not allow hazardous, dangerous, or unsanitary conditions, or public nuisances to develop or persist on-site.
- C. Use of Roadways and Walkways: Do not block or interfere with use of any existing roadway, walkway or other facility for vehicular or pedestrian traffic, from any party entitled to use it. Wherever and whenever such interference becomes necessary for the proper and convenient performance of the Work, and no satisfactory detour route exists, before beginning the interference, notify City and post signs at least 72 hours in advance of such interference, and provide a satisfactory detour, including temporary bridge if necessary, or other proper facility for traffic to pass around or over the interference. Maintain the detour in a safe and satisfactory condition as long as the interference continues, all without extra payment unless otherwise expressly stipulated in the Special Conditions. Refer to [Section 01 55 26 – Temporary Traffic Control](#).

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Provide new materials. If acceptable to the Owner's Representative, the Contractor may use undamaged, previously used materials in serviceable condition. Provide materials suitable for use intended.
- B. Lumber and Plywood:
 - 1. For job-built temporary offices, shops, and sheds within the construction area, provide UL-labeled, fire-treated lumber and plywood for framing, sheathing, and siding.
 - 2. For signs and directory boards, provide exterior-type, Grade B-B high-density concrete form overlay plywood of sizes and thicknesses indicated.
 - 3. For fences and vision barriers, provide minimum 3/8-inch-thick exterior plywood.
 - 4. For safety barriers, sidewalk bridges, and similar uses, provide minimum 5/8-inch-thick exterior plywood.

- C. Gypsum Wallboard: Provide gypsum wallboard on interior walls of temporary offices.
- D. Roofing Materials: Provide UL Class A standard-weight asphalt shingles or UL Class C mineral-surfaced roll roofing on roofs of job-built temporary offices, shops, and sheds.
- E. Paint: Comply with requirements of [Section 09 90 00 – Painting and Coating](#). For sign panels and applying graphics, provide exterior-grade alkyd gloss enamel over exterior primer.
- F. Tarpaulins: Provide waterproof, fire-resistant, UL-labeled tarpaulins with flame-spread rating of 15 or less. For temporary enclosures, provide translucent, nylon-reinforced, laminated polyethylene or polyvinyl chloride, fire-retardant tarpaulins.
- G. Water: Provide potable water approved by local health authorities.
- H. Open-Mesh Fencing: Provide 0.120-inch-thick, galvanized 2-inch chain link fabric fencing 6 feet high with galvanized steel pipe posts; 1-1/2 inches I.D. for line posts and 2-1/2 inches I.D. for corner posts.

2.2 EQUIPMENT

- A. General: Provide new equipment. The Contractor may use undamaged, previously used equipment in serviceable condition. Provide equipment suitable for use intended.
- B. Water Hoses: For non-potable use (construction water) provide 3/4-inch, heavy-duty, abrasion-resistant, flexible rubber hoses 100 feet long, with pressure rating greater than the maximum pressure of the water distribution system. Provide adjustable shutoff nozzles at hose discharge and backflow devices as required per City standards.
- C. Electrical Outlets: Provide properly configured, NEMA-polarized outlets to prevent insertion of 110- to 120-Volt plugs into higher voltage outlets. Provide receptacle outlets equipped with ground-fault circuit interrupters, reset button, and pilot light for connection of power tools and equipment.
- D. Electrical Power Cords: Provide grounded extension cords. Use hard-service cords where exposed to abrasion and traffic. Provide waterproof connectors to connect separate lengths of electric cords if single lengths will not reach areas where construction activities are in progress. Do not exceed safe length-voltage ratio.
- E. Lamps and Light Fixtures: Provide general service lamps of wattage required for adequate illumination. Provide guard cages or tempered-glass enclosures where exposed to breakage. Provide exterior fixtures where exposed to moisture.

- F. Heating Units: Provide temporary heating units that have been tested and labeled by UL, FM, or another recognized trade association related to the type of fuel being consumed.
- G. Temporary Offices: If required by the Special Conditions, provide prefabricated or mobile units or similar job-built construction with lockable entrances, operable windows, and serviceable finishes. Provide heated and air-conditioned units on foundations adequate for normal loading.
- H. Temporary Toilet Units: Provide self-contained, single-occupant toilet units of the chemical, aerated recirculation, or combustion type. Provide units properly vented and fully enclosed with a glass-fiber-reinforced polyester shell or similar nonabsorbent material.
- I. Fire Extinguishers: Provide hand-carried, portable, UL-rated, Class A fire extinguishers for temporary offices and similar spaces. In other locations, provide hand-carried, portable, UL-rated, Class ABC, dry-chemical extinguishers or a combination of extinguishers of NFPA-recommended classes for the exposures.
- J. Comply with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Use qualified personnel for installation of temporary facilities. Locate facilities where they will serve the Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required.
- B. Provide each facility ready for use when needed to avoid delay. Maintain and modify as required. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

- A. General: Engage the appropriate local utility company to install temporary service or connect to existing service. Where company provides only part of the service, provide the remainder with matching, compatible materials and equipment. Comply with company recommendations.
 - 1. Arrange with company and existing users for a time when service can be interrupted, if necessary, to make connections for temporary services.
 - 2. Provide adequate capacity at each stage of construction. Prior to temporary utility availability, provide trucked-in services.
 - 3. Obtain easements to bring temporary utilities to the site where the Owner's

easements cannot be used for that purpose.

- B. Water Service: Install water service and distribution piping of sizes and pressures adequate for construction until permanent water service is in use. Sterilize temporary water piping prior to use in compliance with City Standards. Refer to [Section 33 13 00 - Disinfecting of Water Distribution](#).
- C. Temporary Electric Power Service: Provide weatherproof, grounded electric power service and distribution system of sufficient size, capacity, and power characteristics during construction period. Include meters, transformers, overload-protected disconnects, automatic ground-fault interrupters, and main distribution switchgear. Install wiring overhead and rise vertically where least exposed to damage.
- D. Temporary Lighting: When overhead floor or roof deck has been installed, provide temporary lighting with local switching. Install and operate temporary lighting that will fulfill security and protection requirements without operating the entire system. Provide temporary lighting that will provide adequate illumination for construction operations and traffic conditions.
- E. Temporary Heat: Provide temporary heat required by construction activities for curing or drying of completed installations or for protection of installed construction from adverse effects of low temperatures or high humidity. Select safe equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce the ambient condition required and minimize consumption of energy. Ventilate enclosed areas to achieve curing of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.
- F. Heating Facilities: Except where the Owner authorizes use of the permanent system, provide vented, self-contained, LP-gas or fuel oil heaters with individual space thermostatic control.
- G. Sanitary Facilities: Provide lockable temporary toilets and wash facilities. Comply with regulations and health codes for the type, number, location, operation, and maintenance of fixtures and facilities. Install where facilities will best serve the Project's needs. Locate away from storm drainage inlets and other water bodies. Provide toilet tissue, paper towels, paper cups, and similar disposable materials for each facility. Provide covered waste containers for used material.

3.3 SUPPORT FACILITIES INSTALLATION

- A. Locate field offices, storage sheds, and other temporary construction and support facilities for easy access. Location will be subject to City's approval.
- B. Provide incombustible construction for offices, shops, and sheds located within the construction area or within 30 feet of building lines. Comply with requirements of NFPA 241.
- C. Field Offices: Provide insulated, weather tight temporary offices of sufficient size to accommodate required office personnel at the Project Site. Keep the office clean and orderly for use for small progress meetings.
- D. Storage and Fabrication Sheds: Install storage and fabrication sheds sized, furnished, and equipped to accommodate materials and equipment involved, including temporary utility service. Sheds may be open shelters or fully enclosed spaces within the building or elsewhere on-site.
- E. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities.
 - 1. Where heat is needed and the permanent building enclosure is not complete, provide temporary enclosures where there is no other provision for containment of heat. Coordinate enclosure with ventilating and material drying or curing requirements to avoid dangerous conditions and effects.
 - 2. Install tarpaulins securely, with incombustible wood framing and other materials. Close openings of 25 square feet or less with plywood or similar materials.
 - 3. Close openings through floor or roof decks and horizontal surfaces with load-bearing, wood-framed construction.
- F. Temporary Exterior Lighting: Install exterior yard and sign lights so signs are visible when Work is being performed.
- G. Collection and Disposal of Waste: Collect waste from construction areas and elsewhere daily. Comply with requirements of NFPA 241 for removal of combustible waste material and debris. Enforce requirements strictly. Do not hold materials more than 7 days during normal weather or 3 days when the temperature is expected to rise above 80 deg F. Handle hazardous, dangerous, or unsanitary waste materials separately from other waste by containerizing properly. Dispose of material lawfully.
- H. Rodent and Pest Control: Before deep foundation work has been completed, retain an Integrated Pest Management (IPM) Certified exterminator or pest control company to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests. Employ this service to perform extermination and

control procedures at regular intervals so the Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using EPA recommended environmentally safe materials.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Temporary Fire Protection: Until fire-protection needs are supplied by permanent facilities, install and maintain temporary fire-protection facilities of the types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 10 "Standard for Portable Fire Extinguishers" and NFPA 241 "Standard for Safeguarding Construction, Alterations, and Demolition Operations."
 - 1. Locate fire extinguishers where convenient and effective for their intended purpose, but not less than one extinguisher on each floor at or near each usable stairwell.
 - 2. Store combustible materials in containers in fire-safe locations.
 - 3. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire-protection facilities, stairways, and other access routes for fighting fires. Prohibit smoking in hazardous fire-exposure areas.
 - 4. Provide supervision of welding operations, combustion-type temporary heating units, and similar sources of fire ignition.
- B. Permanent Fire Protection: At the earliest feasible date in each area of the Project, complete installation of the permanent fire-protection facility, including connected services, and place into operation and use. Instruct key personnel on use of facilities.
- C. Barricades, Warning Signs, and Lights: Comply with standards and code requirements for erection of structurally adequate barricades. Paint with appropriate colors, graphics, and warning signs to inform personnel and the public of the hazard being protected against. Where appropriate and needed, provide lighting, including flashing red or amber lights.
- D. Enclosure Fence: Before construction begins, install an enclosure fence with lockable entrance gates. Provide open-mesh, chain link fencing with posts. Locate where indicated, or enclose the entire site or the portion determined sufficient to accommodate construction operations. Install in a manner that will prevent people, dogs, and other animals from easily entering the site, except by the entrance gates.
- E. Security Enclosure and Lockup: Install substantial temporary enclosure of partially completed areas of construction. Provide locking entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security.
- F. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental

regulations, and minimize the possibility that air, waterways, and subsoil might be contaminated or polluted or that other undesirable effects might result. Avoid use of tools and equipment that produce harmful noise. Restrict use of noise-making tools and equipment to hours that will minimize complaints from persons or firms near the site. Contractor is responsible for locking, and any vandalism, theft, unauthorized access and violation are Contractor's responsibility.

3.5 SIGNS

- A. Project Construction Sign: Provide minimum 32-square foot Project identification sign of wood frame and exterior grade plywood construction painted, with exhibit lettering by professional sign painter.

3.6 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. Limit availability of temporary facilities to essential and intended uses to minimize waste and abuse.
- B. Maintenance: Maintain facilities in good operating condition until removal. Protect from damage by freezing temperatures and similar elements.
 - 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
 - 2. Protection: Prevent water-filled piping from freezing. Maintain markers for underground lines. Protect from damage during excavation operations.
- C. Termination and Removal: Remove each temporary facility when the need has ended, when replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with the temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
 - 1. Materials and facilities that constitute temporary facilities are the Contractor's property.
 - 2. Remove temporary paving not intended for or acceptable for integration into permanent paving. Where the area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil in the area. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at the temporary entrances, as required by the governing authority.
 - 3. At Substantial Completion, clean and renovate permanent facilities used during the construction period including, but not limited to, the following:
 - a. Replace air filters and clean inside of ductwork and housings.
 - b. Replace significantly worn parts and parts subject to unusual operating conditions.

- c. Replace lamps burned out or noticeably dimmed by hours of use.

END OF SECTION 01 50 00

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SECTION 01 55 26 – TEMPORARY TRAFFIC CONTROL**PART 1 - GENERAL**

1.1 SUMMARY

- A. Section Includes: temporary traffic control system including preparing and submitting temporary traffic control, pedestrian and bicycle access plans, temporary traffic signal, traffic control for utility trenching and backfill, utility coordination, vehicular traffic control, traffic control for adjacent property owners, traffic control for on-street parking, traffic control for bus stops and coordination with Tri Delta transit, maintaining traffic, temporary railing (type K), temporary crash cushion module, construction area signs, and temporary signing and striping.
- B. All temporary traffic control plans including temporary pedestrian and bicycle access plans submitted by the Contractor shall conform to California Manual of Uniform Traffic Control Devices (CA MUTCD) – Latest Edition.

1.2 REFERENCES

- A. California Manual of Uniform Traffic Control Devices (CA MUTCD) – Latest Edition.
- B. Cal/OSHA – California Division of Occupation Safety and Health
- C. Caltrans Standard Specifications
 - 1. Section 7 – Legal Relations and Responsibility to the Public
 - 2. Section 12 – Temporary Traffic Control

1.3 SUBMITTALS

- A. [Section 01 33 00 - Submittal Procedures](#): Requirements for submittals.
- B. Measurement and Payment:
 - 1. When temporary traffic control is included as a bid item, measurement will be made as a percentage of the costs incurred according to the list submitted except that not more than 75% of the bid price shall be paid prior to the final estimate for payment being due, said remaining 25% paid upon completion of cleanup and removal with final payment.
 - 2. When the contract does not include a contract pay item for temporary traffic control, full compensation for any necessary traffic control required shall be

considered as included in the prices paid for the various contract items of work involved and no additional compensation will be allowed therefore.

3. The adjustment provisions in the State Standard Specifications, Section 4-1.05, "Changes and Extra Work", shall not apply to the item of temporary traffic control system. Any adjustment in compensation for temporary traffic control due to an increase or decrease in the amount of traffic control system required by changes ordered by the Project Manager will be made on the basis of the cost of the increased or decreased temporary traffic control necessary. Such adjustment will be made on a force-account basis as provided in Section 9-1.04, "Force Account", of the State Standard Specifications for increased work.

PART 2 - (NOT USED)

PART 3 - EXECUTION

3.1 TEMPORARY TRAFFIC CONTROL SYSTEM

- A. A temporary traffic control system shall consist of closing traffic lanes in conformance with the CA MUTCD, details shown on the Drawings, the provisions in Section 12, "Temporary Traffic Control", of the State Standard Specifications, the provisions under "Maintaining Traffic", and "Construction Area Signs" of the State Standard Specifications and the General Conditions, Special Conditions, and Technical Specifications.
- B. The provisions in this section will not relieve the Contractor of responsibility for providing additional devices or taking measures as may be necessary to comply with the provisions in Section 7-1.04, "Public Safety," of the State Standard Specifications and CA MUTCD.
- C. During traffic striping and pavement marker placement activities using bituminous adhesive, traffic shall be controlled, at the option of the Contractor, with either stationary or moving lane closures. During other operations, traffic shall be controlled with stationary lane closures. Attention is directed to the provisions in Section 12-6.03, "Construction," of the State Standard Specifications.
- D. If components in the traffic control system are displaced or cease to operate or function as specified, from any cause, during the progress of the work, the Contractor shall immediately repair the components to the original condition or replace the components and shall restore the components to the original location.
- E. A traffic control system shall consist of closing traffic lanes in accordance with the details shown on T-9 through T-17 of the latest edition of the Caltrans Standard Plans, California Manual of Uniform Traffic Control Devices (CA MUTCD), the

contract plans, the provisions of Section 12, " Temporary Traffic Control" of the State Standard Specifications and the General Conditions, Special Conditions, and Technical Specifications.

- F. Each vehicle used to place, maintain, and remove components of a traffic control system on multilane roadways shall be equipped with a Type II flashing arrow sign which shall be in operation when the vehicle is being used for placing, maintaining, or removing said components. The sign shall be controllable by the operator of the vehicle while the vehicle is in motion.
- G. The location of temporary traffic control devices shall be checked by the Contractor especially at the beginning of the work period and periodically throughout the work day, to ensure that the devices are properly placed and maintained.
- H. If any component in the traffic control system is displaced, or ceases to operate or function as specified, from any cause, during the progress of the work, the Contractor shall immediately notify the Project Manager and repair the said component to its original condition or replace said component and shall restore the component to its original location. The cost of providing temporary traffic control as required by the Project Manager shall be considered as included in the cost of traffic control. No additional compensation will be allowed therefor.
- I. The Contractor shall furnish competent Flaggers whose sole duties shall consist of directing the movement of traffic through or around the work. Flaggers shall not be used during the hours of darkness unless authorized by the City.
- J. The Contractor shall conduct all operations with the least possible obstruction and inconvenience to the public. The Contractor shall have under construction no greater length or amount of work than can be completed within a workday with due regards to the rights of the public.
- K. The Contractor shall provide and maintain all traffic control and safety items. The Contractor assumes sole and complete responsibility for the job and site conditions during the course of construction, including safety of all persons and property. This requirement shall apply continuously twenty-four (24) hours/day and shall not be limited to normal work hours.
- L. Personal and work vehicles of the Contractor, subcontractor or the Contractor's employees shall not be parked on the paved shoulders, sidewalk or the traveled way, including any section closed to public traffic. No vehicles of the Contractor shall be parked or driven on the sidewalk.
- M. All personnel occupying the roadway shall be required to wear approved safety vests with protective coloration.
- N. The Contractor shall notify local authorities of his intent to begin work at least five (5) working days before work is begun. The Contractor shall cooperate with local

authorities relative to handling traffic through the area and shall make his own arrangements relative to keeping the working area clear of parked vehicles.

- O. Upon completion of all work requiring use of lane closures, the Contractor shall remove all temporary signs, barricades, and markers and shall return the roadway and roadside areas to a condition equal to that which existed prior to construction.
- P. All asphalt concrete and temporary pavement delineations including pavement markers at the end of each stage shall be considered as a part of Traffic Control work.
- Q. No full road closures are allowed unless approved by the City Manager.
- R. No lane closures will be allowed on weekdays from 6:00 AM to 8:30 AM, or from 3:00 PM to 6:00 PM, except for emergencies or unless otherwise approved by the City Traffic Engineer.
- S. The full width of the traveled way shall be open for use by public traffic on Fridays after 3:00pm, Saturdays, Sundays and designated legal holidays, and when construction operations are not actively in progress.
- T. Two or more lane closures and lane closures with reversible control will not be allowed on weekdays before 9:00 AM, or after 3:00 PM.
- U. The lane closure(s) must be limited in duration and area as practicable and the times and dates of closure must be stated on the approved temporary traffic control plan.
- V. Lane closures and lane reduction shall conform to the provisions in "Maintaining Traffic" of the State Standard Specifications and the CA MUTCD.
- W. When lane closures are made for work periods only, at the end of each work period, all components of the traffic control system, except temporary portable delineators, K-rails and crash cushions placed along open trenches or excavation adjacent to the traveled way shall be removed from the traveled way and shoulder.
- X. To minimize the disruption to traffic, the Contractor shall:
 - 1. Permit local traffic to pass through the work with the least possible inconvenience or delay.
 - 2. Maintain existing driveways, commercial and residential, within the vicinity of the work area, keeping them open and in good, safe condition at all times.
 - 3. Remove or repair any condition resulting from the work that might impede traffic or create a hazard.
 - 4. Keep existing traffic signal and roadway lighting systems in operation throughout the construction work.
 - 5. Maintain continuous ADA accessible pedestrian and bicycle routes.

3.2 TEMPORARY TRAFFIC CONTROL, PEDESTRIAN AND BICYCLE ACCESS PLANS

- A. The Contractor shall provide a Temporary Traffic Control, Pedestrian and Bicycle Access Plans for each stage of construction and for each location.
- B. Temporary Traffic Control, Pedestrian and Bicycle Access Plans will be hand drawn and legible with an approximate graphic scale.
- C. Temporary Traffic Control, Pedestrian and Bicycle Access Plans will show all temporary striping, cones, barricades, channelizers, signs, flaggers, temporary k-rail, crash cushion modules; temporary turn pockets, dimensions of all stripe segments and lane widths, street names, temporary signal modifications, temporary traffic loops, portable changeable message signs, detour signs, construction area signs on all side streets, construction schedule, work hours and all times the temporary traffic control plan will be in effect.
- D. Temporary Traffic Control, Pedestrian and Bicycle Access Plans will also show continuous pedestrian and bicycle path of travel arrows, pedestrian and bicycle signage, pedestrian ADA ramps, bike ramps, temporary pedestrian crosswalks, temporary bike crossings, temporary pedestrian push buttons for signals, pedestrian and bicycle signage on all side streets, pedestrian and bicycle crossing signs, and areas for temporary ADA upgrades along the pedestrian path of travel.
- E. Temporary Traffic Control, Pedestrian and Bicycle Access Plans will be submitted to the City Traffic Engineer two (2) weeks prior to commencement of each stage of construction. The Temporary Traffic Control, Pedestrian and Bicycle Access Plans shall be reviewed by the City Traffic Engineer. Contractor to incorporate all comments from the City Traffic Engineer and resubmit the plans for approval prior to implementation. Assume two (2) rounds of review and resubmittal for each stage of construction.
- F. Once any segment of sidewalk or trail or corner is commenced with sawcut and/or any segment of sidewalk/trail is closed to pedestrians and bicyclists, Contractor will backfill and complete the improvements unless an approved detour plan is provided and approved by the City Traffic Engineer.

3.3 TRAFFIC SIGNAL

- A. If traffic signal inductive vehicle loop detectors and lead-in wiring not designated to be replaced on the Plans are damaged during the course of the construction period, they shall be replaced within one (1) week or as directed by the Project Manager. The cost of replacing damaged loop detectors including detector handholes or any other necessary repairs to the components of the traffic signal system shall be included in the cost of traffic control. No additional compensation will be allowed therefore.

3.4 UTILITY COORDINATION

- A. Contractor shall notify the utility companies as a first order of work about the project and submit a detailed project schedule to all utility companies.
- B. Each stage of construction shall allow for utility companies to complete their work. If Utility company's utilities are to be constructed, adjusted or relocated. the Contractor shall provide four (4) week window during each stage of construction for utility companies to have unobstructed access to the site. This four (4) week period will likely occur after demolition and setting of curb forms by the Contractor. The related utility work shall be coordinated with the utility companies prior to the two (2) week window. The Contractor shall also allow utility companies to work on site during the remaining time of each construction stage.
- C. The construction schedule shall identify the related utility work during each stage and shall be submitted for approval. Changes during construction that will impact the related utility work shall be identified on the Progress Schedule.
- D. The Contractor shall notify to the utility companies and the Project Manager immediately of any changes to the schedule.

3.5 TEMPORARY TRAFFIC CONTROL FOR UTILITY TRENCHING & BACKFILL

- A. All excavations shall be backfilled or covered at the end of each workday. Trench covers will be constructed to withstand pedestrian, bicyclist and vehicle loads. Trench covers in the vehicle areas will be steel plated to withstand vehicle loads. All trench covers shall be non-skid. In sidewalk areas, AC cutback shall be used as temporary ramps. Contractor shall maintain temporary AC surface to provide safe and comfortable passage over or along same, for pedestrian, bicyclist and vehicular traffic to the satisfaction of the Inspector in the field. Items which will require trench plates include, but are not limited to: storm drain, sewer, water main trenches, and irrigation crossings. Contractor to submit shop drawings to demonstrate method of trench plating, anchoring and asphalt tapers.
- B. The Contractor shall comply with the provisions in Section 7-1.02K(6), "Occupational Safety and Health Standards" of the State Standard Specifications.
- C. Spillage resulting from hauling operations along or across any public traveled way shall be removed immediately by the Contractor. The Contractor shall leave the project site in a neat, clean, and presentable state at the close of every workday.
- D. If material from the trench excavation spills onto the roadway, the roadway area shall be swept and washed with water to provide a safe and dust free surface before the lane is re-opened.

- E. The Contractor shall conform to the order of work requirements described on the plans and specifications. If the work items are not completed by the time specified, including any extension of time for excusable delays, the Contractor shall be liable to the City for any additional cost incurred by the City in its completion of the work, and the Contractor shall also be liable to the City for liquidated damages for any delay in the completion of the work.

3.6 TRAFFIC CONTROL FOR ADJACENT PROPERTY OWNERS

- A. A. The Contractor shall notify residents/businesses within a closed section by door hanger of sidewalk closures stating the date(s) of closure, limits of sidewalk closure, hours of construction, and detours. The door hangers shall be delivered no later than two (2) working days prior to sidewalk closure. Prior to dissemination, the Contractor shall present a copy to the Project Manager and get approval from the Project Manager for the door hanger.
- B. Work shall be accomplished in such a manner as to provide access to all intersecting streets and adjacent properties whenever possible. If during the course of the work, it is necessary to restrict access to certain driveways for an extended period of time, the Contractor shall
 1. Notify the affected residents, in writing, at least two (2) working days in advance.
 2. Provide signage and provide continuous Flaggers to direct traffic in and out of the parking.
 3. Maintain 11' minimum width.
 4. Reopen driveway by the end of the work day.
 5. Include the signage and Flaggers on the Traffic Control and Pedestrian Access Plans.
- C. To protect the rights of abutting property owners, the Contractor shall
 1. Conduct the construction so that the least inconvenience as possible is caused to abutting property owners.
 2. Maintain ready access to houses or businesses along the line of work, including ramps over work area.
 3. Notify all parties at least five (5) days, and again two (2) working days, in advance of work which would affect their property. The Contractor shall coordinate with City to obtain Right of Entry for any work within private property.
 4. The Contractor shall maintain access to adjacent private property at all times, and shall address driveway access on approved Traffic Control Plans.
 5. For Utility company and Developer projects, permittee shall obtain right of entry for any work in private properties.
 6. The Contractor shall maintain safe pedestrian and bicycle access at all times, including crosswalks, when it is required to close sidewalks.

7. Contractor shall provide Temporary Pedestrian and Bicycle Access Plan for any change in pedestrian and bicycle movements. All openings shall be covered or steel plated at the end of each workday, when working in an intersection and traffic lane. Covers in pedestrian areas shall be non-skid and ADA compliant. Contractor shall maintain temporary AC surface to provide safe and comfortable passage over or along same, for pedestrian, bicyclist and vehicular traffic to the satisfaction of the Inspector in the field.
8. The Contractor shall provide temporary pedestrian bridges and walkways as shown on Contractor's approved Temporary Traffic Control Plans. Temporary pedestrian bridges shall be provided to each affected doorway.

3.7 TRAFFIC CONTROL FOR ON-STREET PARKING:

- A. To maintain On-Street parking, the Contractor shall provide temporary signs for any existing On-Street parking closure and coordinate with adjacent businesses. Contractor shall restripe the existing On-Street Parking impacted by construction in-kind as required by the Project Manager within the project limits.
- B. The Contractor shall post City approved parking restrictions a minimum two (2) working days before work begins. All legal parking areas must be maintained and access to legally parked vehicles doors and storage areas must be maintained.
- C. Parking restrictions must be limited in time as practicable.

3.8 TRAFFIC CONTROL FOR BUS STOPS AND COORDINATION WITH TRANSIT AGENCY (TRI DELTA TRANSIT)

- A. If construction shall obstruct a bus stop, the Contractor shall notify the Transit Agency two (2) working days in advance. The Contractor shall be responsible for providing temporary bus stop with temporary bench, bus stop signs posts and no parking signs at locations specified by Transit Agency within a distance of maximum of 400' from existing bus stop.
- B. The Contractor shall be responsible for providing adequate safeguards, safety devices, protective equipment, and any other needed actions to protect life, health, and safety of the public, and to protect property in connection with the performance of the work covered by the contract. The Contractor shall perform any measures or actions the Project Manager may deem necessary to protect the public and property. Contractor shall install K-rail at all new bus stop pad construction areas.

3.9 MAINTAINING TRAFFIC

- A. Maintaining traffic shall conform to CA MUTCD, the provisions in Sections 7-1.03, "Public Convenience," Section 7-1.04, "Public Safety," and Section 12,

"Temporary Traffic Control," of the State Standard Specifications, and the City Standard Specifications.

- B. Closure is defined as the closure of a traffic lane or lanes, including shoulder, ramp or connector lanes, within a single traffic control system.
- C. The full width of the traveled way shall be open for use by public traffic as specified in Part 3.1 above, when construction operations are not actively in progress.
- D. Personal and work vehicles of the Contractor, subcontractor or the Contractor's employees shall not be parked on the traveled way or shoulders including sections closed to public traffic.
- E. The Contractor shall immediately restore to the original position and location a temporary traffic cone or delineator that is displaced or overturned, during the progress of work.
- F. If minor deviations from the Contractor's approved lane closure requirements are required, a written request shall be submitted to the City Traffic Engineer at least 15 days before the proposed date of the closure. The City Traffic Engineer may approve the deviations if there is no increase in the cost to the City and if the work can be expedited and better serve the public traffic.
- G. Designated legal holidays are:

Holidays

Holiday	Date observed
New Year's Day	January 1 st
Martin Luther King Jr. Day	3 rd Monday in January
Lincoln's Birthday	February 12 th
Washington's Birthday	3 rd Monday in February
Cesar Chavez Day	March 31 st
Memorial Day	Last Monday in May
Independence Day	July 4 th
Labor Day	1 st Monday in September
Columbus Day	2 nd Monday in October
Veterans Day	November 11 th
Thanksgiving Holidays	4 th Thursday and Friday in November
Christmas Day	December 25 th

If a designated holiday falls on a Sunday, the following Monday is a designated holiday. If November 11th falls on a Saturday, the preceding Friday is a designated holiday.

- H. Pedestrian and Bicycle access facilities shall be provided through construction areas within the public right of way as shown on the Contractor's approved Temporary Traffic control, Pedestrian and Bicycle Access plans and as specified herein. Pedestrian walkway shall be surfaced with asphalt concrete, Portland cement concrete or timber. The surface shall be skid resistant and free of irregularities. Hand railings shall be provided on each side of pedestrian walkways as necessary to protect pedestrian traffic from hazards due to construction operations or adjacent vehicular traffic. Protective overhead covering shall be provided as necessary to insure protection from falling objects and drip from overhead structures. If the Contractor's operations require the closure of one walkway, then another walkway shall be provided nearby, off the traveled roadway.
- 3.10 CONTINGENCY PLAN: A detailed contingency plan shall be prepared for reopening closures to public traffic. The contingency plan shall be submitted to the Project Manager within one (1) business day of the Project Manager's request.
- 3.11 LATE REOPENING OF CLOSURES
- A. If a closure is not reopened to traffic by the specified time, work shall be suspended in conformance with the provisions in Section 8-1.06, "Suspensions" of the State Standard Specifications. No further closures are to be made until the City Traffic Engineer has accepted a work plan, submitted by the Contractor that will insure that future closures will be reopened to traffic at the specified time. The City Traffic Engineer will have two (2) business days to accept or reject the Contractor's proposed work plan. The Contractor will not be entitled to compensation for the suspension of work resulting from the late reopening of closures.
- B. For each 10-minute interval, or fraction thereof past the time specified to reopen the closure, City will deduct payments per interval from moneys due or that may become due the Contractor under the contract. See deductible schedule below:
1. Residential Streets - \$50 per 10 minutes
 2. Collector Streets - \$100 per 10 minutes
 3. Arterial Streets - \$400 per 10 minutes.
- 3.12 TEMPORARY RAILING (TYPE K)
- A. Temporary railing (Type K) shall be placed as shown on the Contractor's approved Temporary Traffic Control, Pedestrian and Bicycle Access plans, as specified in the Drawings or where ordered by the Project Manager and shall conform to CA MUTCD, the provisions in Section 12, "Temporary Traffic Control" of the State Standard Specifications and the City Standard Specifications.

- B. Temporary railing (Type K) shall consist of interconnected new or undamaged used precast concrete barrier units as shown on the Contractor's approved Temporary Traffic Control, Pedestrian and Bicycle Access plans. Exposed surfaces of new and used units shall be freshly coated with a white color paint prior to their first use on the project. The paint shall conform to the provisions in Section 91-4.02B, "Acrylic Emulsion Paint for Exterior Masonry" of the State Standard Specification.
- C. Concrete shall conform to the provisions in Section 90-2, "Minor Concrete" of the State Standard Specifications. Load tickets and a Certificate of Compliance will not be required.
- D. Reinforcing steel shall conform to the provisions in Section 52, "Reinforcement" of the State Standard Specifications.
- E. Steel bars to receive bolts at ends of concrete panels shall conform to the requirements in ASTM Designation: A 36. The bolts shall conform to the requirements in ASTM Designation: A 307.
- F. The final surface finish of temporary railings (Type K) shall conform to the provisions in Section 51-1.03F(2), "Ordinary Surface Finish" of the State Standard Specifications. Exposed surfaces of concrete elements shall be cured by the water method, the forms in place method, or the pigmented curing compound method. The pigmented curing compound shall be curing compound (1) as specified in Section 90-1.03B(3), "Curing Compound Method" of the State Standard Specifications. The Contractor shall furnish a Certificate of Compliance to the Project Manager in conformance with the provisions in Section 6-2.03C "Certificates of Compliance" of the State Standard Specification, for all new or used temporary railing (Type K) that is not cast on the project.
- G. Temporary railing (Type K) shall be set on firm, stable foundation. The foundation shall be graded to provide a uniform bearing throughout the entire length of the railing. Any excavation and backfill shall conform to the provisions in Section 19-3, "Structure Excavation and Backfill" of the State Standard Specification except that compaction of earth fill placed behind the temporary railing (Type K) in a curved layout will not be required.
- H. Abutting ends of precast concrete units shall be placed and maintained in alignment without substantial offset to each other. The precast concrete units shall be positioned straight on tangent alignment and on a true arc on curved alignment.
- I. At the locations required on the plans, threaded rods or dowels shall be bonded in holes drilled in the existing concrete. Drilling of holes and bonding of threaded rods or dowels shall conform to the provisions for bonding dowels in Section 83-3.01A, "Summary" of the State Standard Specifications. After removal of the temporary railing (Type K), all threaded rods or dowels shall be removed to a

depth of at least one inch below the surface of the concrete. The resulting holes shall be filled with mortar in conformance with the provisions in Section 51-1.02F, "Mortar" of the State Standard Specification, except that the mortar shall be cured by either the water method or by the curing compound method. If the curing compound method is used, the curing shall conform to the provisions for curing concrete barrier in Section 83-3.03A(8), "Curing" of the State Standard Specifications.

- J. Each rail unit shall have a reflector installed on top of the rail. Reflectors shall be as specified in the technical specifications, and adhesive shall conform to the reflector manufacturer's recommendations. A Type P marker panel shall also be installed at each end of railing installed adjacent to a two lane, two-way highway and at the end facing traffic of railing installed adjacent to a one-way roadbed. If the railing is placed on a skew, the marker shall be installed at the end of the skew nearest the traveled way. Type P marker panels shall conform to the provisions in Section 82, "Signs and Markers" of the State Standard Specifications, except that the Contractor shall furnish the marker panels.
- K. When temporary railings (Type K) are removed, any area where temporary excavation or embankment was used to accommodate the temporary railing shall be restored to its previous condition or constructed to its planned condition.
- L. Prior to each stage of construction Contractor will provide a layout of the proposed temporary railing, crash cushion locations, and temporary striping/signing for the railing.
- M. Water filled barriers will be considered in lieu of temporary railings (Type K), upon a written request from the contractor along with proposed details, layout plan, temporary signing & striping and installation.

3.13 TEMPORARY CRASH CUSHION MODULE

- A. This work shall consist of furnishing, installing, and maintaining sand filled temporary crash cushion modules in groupings or arrays at each location shown on the Contractor's approved traffic control plans, as specified in the technical specifications or where designated by the Project Manager. The grouping or array of sand filled modules shall form a complete sand filled temporary crash cushion in conformance with the details shown on the plans and the technical specifications.
- B. Temporary crash cushions shall be secured in place prior to commencing work for which the temporary crash cushions are required.
- C. Whenever the work or the Contractor's operations establishes a fixed obstacle, the exposed fixed obstacle shall be protected with a sand filled temporary crash cushion. The sand filled temporary crash cushion shall be in place prior to opening the lanes adjacent to the fixed obstacle to public traffic.

- D. Sand filled temporary crash cushions shall be maintained in place at each location, including times when work is not actively in progress. When no longer required, as determined by the Project Manager, sand filled temporary crash cushions shall be removed from the site of the work.
- E. Modules contained in each temporary crash cushion shall be of the same type at each location. The color of the modules shall be the standard yellow color, as furnished by the vendor, with black lids. The modules shall exhibit good workmanship free from structural flaws and objectionable surface defects. The modules need not be new. Good used undamaged modules conforming to color and quality of the types specified herein may be utilized.
- F. Modules shall be filled with sand in conformance with the manufacturer's directions, and to the sand capacity in pounds for each module shown on the plans. Sand for filling the modules shall be clean washed concrete sand of commercial quality. At the time of placing in the modules, the sand shall contain no more than 7 percent water as determined by California Test 226.
- G. Modules damaged due to the Contractor's operations shall be repaired immediately by the Contractor at the Contractor's expense. Modules damaged beyond repair, as determined by the Project Manager, due to the Contractor's operations shall be removed and replaced by the Contractor at the Contractor's expense.
- H. A Type R or P marker panel shall be attached to the front of the crash cushion. The marker panel, when required, shall be firmly fastened to the crash cushion with commercial quality hardware or by other methods determined by the Project Manager.
- I. At the completion of the project, temporary crash cushion modules, sand filling, pallets or frames, and marker panels shall become the property of the Contractor and shall be removed from the site of the work. Temporary crash cushion modules shall not be installed in the permanent work.
- J. Repairing modules damaged by public traffic and modules damaged beyond repair by public traffic, when ordered by the Project Manager, shall be removed and replaced immediately by the Contractor. Modules replaced due to damage by public traffic will be not be measured and paid for and shall be considered as included in the lump sum price paid for Temporary Traffic Control.
- K. Include allowance for Project Manager to order a lateral move of the sand filled temporary crash cushions where the repositioning is not shown on the Contractor's approved traffic control plans. Moving the sand filled temporary crash cushion will be considered as included in the lump sum price paid for Temporary Traffic Control and no additional compensation will be allowed therefore and these temporary crash cushion modules will not be counted for payment in the new position.

3.14 CONSTRUCTION AREA SIGNS

- A. Construction area signs shall be furnished, installed, maintained, and removed when no longer required in accordance with CA MUTCD, the provisions in Section 12-3.11, "Construction Area Signs," of the State Standard Specifications, the contract drawings, and the General Conditions, Special Conditions, and Technical Specifications. The base material of construction area signs shall not be plywood. This includes but not limited to furnishing and installation of Pedestrian and Bicycle Signs.

END OF SECTION 01 55 26

SECTION 01 56 10 – PROTECTION OF PROPERTY**PART 1 - GENERAL****1.1 SUMMARY****A. Section Includes:**

1. Existing Utilities and Improvements
2. Safeguarding of Existing Facilities
3. Restoration of Pavement
4. Emergency Work
5. Preconstruction Site Documentation

B. Related Sections:

1. [Section 01 50 00 – Temporary Facilities and Controls](#)
2. [Section 01 32 00 – Construction Progress Documentation](#)

1.2 EXISTING UTILITIES AND IMPROVEMENTS**A. Underground Facilities:** Notify Underground Service Alert (U.S.A.) prior to excavating at the site so that utility companies and other City departments having underground facilities in the area may be advised of the work and may field mark or otherwise protect and warn Contractor of their existing utility lines.

1. Provide reasonable access and do not hinder or otherwise interfere with any company or agency having underground facilities in removing, relocating, or protecting such facilities.

B. Excavations: Verify the actual locations and depths of all utilities indicated or field marked. Make a sufficient number of exploratory excavations of all utilities that may interfere with the Work sufficiently in advance of construction to avoid possible delays to Contractor's work.

1. Notify the City when such exploratory excavations show the utility location as shown or as marked to be in error.
2. When utility lines are encountered within the area of Contractor's operations, notify the Project Manager and the Owner(s) of the utility lines sufficiently in advance for the necessary protection measures to be taken to prevent interruption of service or delay to Contractor's operations.

1.3 SAFEGUARDING OF EXISTING FACILITIES**A. Damage:** Perform all work, including dewatering operations, in such a manner as to avoid damage to existing sewer and water systems, fire hydrants, power poles, lighting standards, and all other existing utilities, facilities, trees and vegetation, and structures. The Contractor will be held responsible for any damage due to its failure to exercise due care, and at no cost to the City.

- B. Removal and Disposal: Broken concrete, debris, and the like, shall be immediately removed from the property site as the Contractor's property and disposed of in a legal manner.
- C. Existing Facilities: Exercise due care to avoid damage to existing pipe and coating, wrapping, sewers, conduit, or other existing facilities and structures. Should the Contractor damage or displace any of the above, repair same to the satisfaction of the Project Manager; all expenses in connection therewith shall be borne solely by the Contractor.
- D. Sewer System: Do not allow debris to enter the sewer system.

1.4 RESTORATION OF PAVEMENT

- A. General: All paved areas cut or damaged during construction shall be replaced with materials of equal thickness to match the existing undisturbed areas, except where specific resurfacing requirements are called for in the Contract Documents or in the permit requirements of the agency issuing the permit. All pavements which are subject to partial removal shall be neatly saw cut in straight lines.
- B. Temporary Resurfacing: Place temporary surfacing promptly after backfilling and maintain such surfacing in a satisfactory condition for the period of time before proceeding with the final restoration.
- C. Permanent Resurfacing: Damaged edges of pavement along excavations and elsewhere shall be trimmed back by saw cutting in neat straight lines. All pavement restoration shall be constructed to finished grades compatible with undisturbed adjacent pavement.
- D. Restoration of Sidewalks or Driveways: Wherever sidewalks, curbs and gutters, or driveways have been removed for construction purposes, place suitable temporary sidewalks, curbs and gutters, or driveways promptly after backfilling and maintain them in satisfactory condition for the period of time before the final restoration has been made.

1.5 EMERGENCY WORK

- A. General: At all times have adequate personnel, materials, and equipment available at short notice to protect adjoining property, maintain, or make emergency repairs. If during the progress of the Contract, the Contractor's construction crews should be absent from the location of the work at a time when any failure or faulty condition of the Contractor's work requires emergency action in the public interest, the City shall have the right to make repairs and corrections as required with its own forces at the Contractor's expense.
- B. Contact Information: Furnish the Project Manager with names and telephone numbers of at least three (3) persons to contact in case of emergencies; these

persons shall be authorized to perform such work as deemed necessary by the Project Manager.

1.6 PRECONSTRUCTION SITE DOCUMENTATION

- A. Prevention of Damage: Use such methods and take adequate precautions to prevent damage to existing buildings, structures, and other improvements during the prosecution of the work.
- B. Joint Examination: After the Contract is awarded and before the commencement of work, the Project Manager will arrange for a joint examination of the work, as applicable, which might be damaged by the Contractor's operations
- C. Scope of Examination: The examination will include the exterior of existing buildings, structures, and other improvements located within twenty-five (25) feet of the construction excavation. Examination will be made jointly by authorized representatives of the Contractor, the City, and property owners under the supervision of the Project Manager. The scope of each examination will include, but is not limited to, written and photographic recording of cracks in structures, settlement, leakage, and the like.
- D. Photos and Videos: Take photos and videos during the joint examination review. Provide digital photos and videos to the Project Manager within thirty (30) consecutive days of the date taken.
- E. Use of Records and Photographs: Any and all records and photographs are intended for use as indisputable evidence in ascertaining the extent of any damage which may occur as a result of the Contractor's operations. They are for the protection of the adjacent property owners, the Contractor, and the City and will be a means of determining whether and to what extent damage, resulting from the Contractor operations, occurred during the Contract Work.
- F. Requirements for Photographs and Videos: Refer to [Section 01 32 00 – Construction Progress Documentation](#).

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION 01 56 10

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SECTION 01 57 23 – STORM WATER POLLUTION PREVENTION**PART 1 - GENERAL**

1.1 SUMMARY

- A. Section Includes: requirements for temporary utilities, support facilities, storm water pollution prevention, erosion control, traffic control, support, and security and protection facilities.
- B. Projects that have a soil disturbance of one acre or greater are subject to the State Water Resources Control Board's (SWRCBs) Construction General Permit. The appropriate Legally Responsible Person (LRP), or approved representative must obtain coverage by filing the Permit Registration Documents (PRDs) prior to commencement of any construction activity. A Stormwater Pollution Prevention Plan (SWPPP) shall be prepared by a Qualified SWPPP Developer (QSD) and submitted to the City prior to issuance of a grading permit. Contractor shall comply with all requirements of SWRCBs Construction General Permit Order No. 2009-0009-DWQ, and amended Orders 2010-0014-DWQ, and 2012-0006-DWQ.
- C. Projects that are less than one acre and are Caltrans related (State Highway Projects) are required to have a Water Pollution Control Plan (WPCP) prepared in accordance with Caltrans' standard WPCP template.
- D. Projects that are less than one acre and are not Caltrans related are required to have an Erosion and Sedimentation Control Plan prepared and submitted to the City for approval prior to issuance of a grading permit.

1.2 PRICE AND PAYMENT PROCEDURES

- A. [Section 01 29 00 - Payment Procedures](#)
- B. Notice of Intent (NOI) and Annual Permit Fees for Capital Improvement Projects shall be paid by the City.
- C. The Developers shall pay all associated Construction General Permit (CGP) fees for all new development/redevelopment projects requiring a permit from the City.

1.3 REFERENCES:

- A. California Stormwater Quality Association (CASQA) has developed a standard SWPPP template for traditional Risk 1,2, and 3 projects that is prevalent in California and can be downloaded from www.CASQA.org. (Note: An annual subscription is required to access to access the CASQA construction portal.)
- B. SWPPP: The Stormwater Pollution Prevention Plan (SWPPP) shall be designed to comply with California's General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (General Permit) Order No. 2009-0009-DWQ as amended by Order No. 2010-0014-DWQ (NPDES No. CAS000002) and 2012-0006-DWQ, Waste Discharge Requirements (WDRs) for Discharges of Storm Water Runoff Associated with Construction Activity (herein after referred to as General Permit) issued by the State Water Resources Control Board (State Water Board). In accordance with the General Permit, Section XIV, designed to address the following:
 1. Pollutants and their sources, including sources of sediment associated with construction, construction site erosion and other activities associated with construction activity are controlled.
 2. Where not otherwise required to be under a Regional Water Quality Control Board (Regional Water Board) permit, all non-stormwater discharges are identified and either eliminated, controlled, or treated.
 3. Site Best Management Practices (BMPs) are effective and result in the reduction or elimination of pollutants in stormwater discharges and authorized non-stormwater discharges from construction activity to the Best Available Technology/Best Control Technology (BAT/BCT) standard.
 4. Calculations and design details as well as BMP controls are complete and correct.
 5. Stabilization BMPs will be installed to reduce or eliminate pollutants after construction is completed.

1.4 SUBMITTALS

- A. Notice of Intent (NOI): The Legally Responsible Person shall file the Notice of Intent (NOI) and submit all PRDs to the SWRCB prior issuance of a grading permit. For City Capital Improvement Projects, the Contractor shall file the NOI and submit all PRDs to the SWQRB on behalf of the City. Contractor to obtain the Waste Discharge Identification Number (WDID #) on behalf of the City, or as otherwise directed by the City Engineer.
- B. SWPPP:
 1. Contractor shall submit SWPPP for Project Manager's review within ten (10) calendar days after award of project.
 2. The Contractor shall submit a site-specific Storm Water Pollution Prevention Plan (SWPPP) prepared by a Qualified SWPPP Developer (QSD) the Contractor shall amend the SWPPP when required, prepare a Construction

- Site Monitoring Plan (CSMP), and perform water pollution control work under the oversight of a Qualified SWPPP Practitioner (QSP), as specified in the General Permit. The Contractor shall identify an individual to be a Data Submitter (DS) for this contract. All reports and data that must be submitted to the State Water Resources Control Board will be uploaded by the Contractor's DS to the Stormwater Multi-Application and Report Tracking System (SMARTS) website for certification to the state by the City Legally Responsible Person (LRP) or their Approved Signatory (A/S).
3. The QSD, QSP, and DS designated by the Contractor may be different individuals.
 4. Storm Water Pollution Prevention Plan (SWPPP):
The Contractor shall prepare and submit a site-specific Storm Water Pollution Prevention Plan (SWPPP) to the City Engineer for approval. The SWPPP shall be prepared and certified by a Qualified SWPPP Developer (QSD) holding one of the certifications or registrations listed in Section VII of the Construction General Permit. Within seven (7) working days after contract award, the Contractor shall submit two (2) printed copies of the SWPPP and Site Map and one electronic copy in electronic file (.pdf) format to the Project Manager for review. The Contractor shall allow five (5) working days for the Project Manager's review. If revisions are required, the Project Manager will provide comments, and the Contractor shall revise and resubmit the SWPPP and Site Map in printed and electronic form within five (5) working days of receipt of the Project Manager's comments. Within three (3) working days of receipt of the City Engineer's approved SWPPP, the Contractor shall submit three (3) paper copies of the approved SWPPP to the City Engineer. Once the City Engineer has approved the SWPPP for the project, the Contractor may proceed with construction activities requiring coverage under the General Permit.
 5. WDID Number: The Contractor shall not perform work that may cause water pollution until the state has issued a WDID number for the project. The City Engineer's review and approval of the SWPPP shall not waive any contract requirements and shall not relieve the Contractor from complying with Federal, State and local laws, regulations, and requirements. Working days shall not be counted if the controlling item of work cannot be performed during the initial preparation and review of the SWPPP and Site Map and between the date that the approved SWPPP has been received by the City Engineer, and the date the City Engineer has notified the Contractor that a WDID number has been assigned to the project.
 6. Approved SWPPP: The Contractor shall keep a copy of the approved SWPPP at the job site at all times during construction. The SWPPP shall be made available when requested by a representative of the Regional Water Quality Control Board, State Water Resources Control Board, United States Environmental Protection Agency, or the local storm water management agency. Requests from the public shall be directed to the Project Manager.

C. WPCP

1. General: Contractor shall submit WPCP for City review within ten (10) calendar days after award of project.
2. Water Pollution Control Plan:
The Contractor shall prepare and submit a site-specific Water Pollution Control Plan (WPCP) to the Project Manager and Construction for approval. Within seven (7) working days after contract award, the Contractor shall submit two (2) printed copies of the WPCP and Site Map and one electronic copy in electronic file (.pdf) format to the Project Manager for review. The Contractor shall allow five (5) working days for the Project Manager's review. If revisions are required, the Project Manager will provide comments, and the Contractor shall revise and resubmit the WPCP and Site Map in printed and electronic form within five (5) working days of receipt of the Project Manager's comments. Within three (3) working days of receipt of the Project Manager's approved WPCP, the Contractor shall submit three (3) paper copies of the approved WPCP to the Project Manager. Once the Project Manager has approved the WPCP for the project, the Contractor may proceed with construction activities.

The Contractor shall keep a copy of the approved WPCP at the job site. The WPCP shall be made available when requested by a representative of the Regional Water Quality Control Board, State Water Resources Control Board, United States Environmental Protection Agency, or the local storm water management agency. Requests from the public shall be directed to the Project Manager.

1.5 WATER POLLUTION CONTROL DRAWING/EROSION CONTROL PLAN

- A. General: Contractor shall include a Water Pollution Control Drawing (WPCD) / Erosion and Sediment Control Plan (ESCP) as a part of the SWPPP/WPCP. Revisions and Amendments to the WPCDs shall be prepared and uploaded to SMARTS by Contractor's QSP and/or QSD.
- B. For any State Highway projects, Contractor shall provide a Water Pollution Control Drawing as required by Caltrans. Contractor to provide an Erosion and Sedimentation Control Plan to the Engineering Division for review and approval prior to issuance of a grading permit.
- C. Deficiencies: The Contractor shall construct, inspect, maintain, remove, and dispose of the water pollution control measures. If the Contractor, the Contractor's QSP, or the City Engineer and/or his representative identifies a deficiency in the implementation of the approved SWPPP/WPCP, the deficiency shall be corrected immediately, and at a minimum of 72 Hours. The deficiency shall be corrected before the onset of precipitation. If the Contractor fails to

correct the deficiency by the 72-hour timeframe or before the onset of precipitation, the Project Manager may correct the deficiency and deduct the cost of correcting deficiencies from payments. If the Contractor fails to conform to the provisions of this section, the Project Manager may order the suspension of work until the project complies with the requirements of the Construction General Permit and this section.

- D. Weather Forecasts: The Contractor shall monitor the National Oceanic and Atmospheric Administration (NOAA) weather forecast on a daily basis during the contract. The Contractor shall perform SWPPP/WPCP Inspections according to the Risk Level. The Contractor will provide soil stabilization and sediment control practices whenever there is a 50% probability of rain within 48 hours as predicted by the NOAA. The Contractor shall maintain soil stabilization and sediment control materials on site to protect disturbed soil areas throughout the life of construction project.

1.6 IMPLEMENTATION REQUIREMENTS

- A. QSP: The Contractor shall designate in writing a Qualified SWPPP Practitioner (QSP) who shall be responsible for non-storm water and storm water visual observations and inspections, and for ensuring that all BMP required by the SWPPP/WPCP and General Construction Permit are properly implemented and maintained. The QSP shall meet the training and certification requirements in the Construction General Permit.
- B. SWPPP Requirements: All measures required by the SWPPP/WPCP shall be implemented concurrent with the commencement of construction. No construction may start without all BMPs in place. Pollution practices and devices shall be followed or installed as early in the construction schedule as possible with frequent upgrading of devices as needed as construction progresses to protect water quality at all times.
- C. Inspection and Maintenance: The Contractor's Qualified SWPPP Developer (QSD) shall develop and implement a written site-specific Construction Site Monitoring Program (CSMP) in accordance with the requirements of the General Permit and the Technical Specifications, and Contractor's QSP shall monitor the water pollution control practices identified in the General Permit and SWPPP as follows:
 - 1. Visual Inspections, Quarterly Non-storm water discharge
 - 2. Minimum of Weekly Visual Inspections of all Best Management Practices (BMP) that need maintenance to operate effectively, that have failed or that could fail to operate as intended.
 - 3. BMP Inspections, Baseline Pre-storm event
 - 4. Rain Event Action Plan (REAP)
 - 5. BMP Inspections, 24-Hours during extended rain events
 - 6. BMP Inspections, Post-storm event.

- D. The QSP shall oversee the maintenance of the water pollution control practices. The QSP shall document all visual inspection activities with written reports according to the requirements of the Construction General Permit. The format of the reports shall be approved by the Project Manager.
- E. A copy of all written reports documenting implementation of the CSMP shall be submitted to the Project Manager within 48 hours of finishing the inspection and shall remain on site during construction.
- F. Reporting Requirements: If the Contractor identifies discharges into surface waters or drainage systems causing or potentially causing pollution, or if the project receives a written notice or order from a regulatory agency, the Contractor shall immediately inform the Project Manager. The Contractor shall submit a written report to the Project Manager within 24 hours of the discharge, notice or order. The report shall include the following information:
 - 1. The date, time, location, nature of the operation, type of discharge; and the cause of the notice or order.
 - 2. The water pollution control practices used before the discharge, or before receiving the notice or order.
 - 3. The date of placement and type of additional or altered water pollution control practices placed after the discharge, or after receiving the notice or order.
 - 4. A maintenance schedule for affected water pollution control practices.
- G. Annual Report: The Contractor shall complete and submit to the City Engineer an Annual Report, as required by the current State Water Board Industrial General Permit. The Contractor shall submit the Annual Report prior to acceptance of the project. Contractor shall submit the annual report to the SWRCB directly on SMARTS.

1.7 COMPLETION OF WORK

- A. Maintenance: Clean-up shall be performed as each portion of the work progresses. All refuse, excess material, and possible pollutants shall be disposed of in a legal manner off-site and all temporary and permanent BMP devices shall be in place and maintained in good condition.
- B. Records: At completion of work, inspect installed BMP devices, and present the currently implemented SWPPP/WPCP with all backup records to the Project Manager.
- C. BMPs: Contractor must remove all construction materials, temporary facilities, temporary BMPs, equipment and construction related materials from the site.
- D. NOTICE OF TERMINATION (NOT): A Notice of Termination (NOT) must be submitted by the Contractor to the City Engineer for electronic submittal by the LRP via SMARTS to terminate coverage under the General Permit. The NOT

must include a final Site Map and representative photographs of the project site that demonstrate final stabilization has been achieved. The NOT shall be submitted to the City Engineer within 10 days of completion of construction. The NOT will be reviewed and submitted to SMARTS by the City Engineer within 90 days of completion of construction. The Regional Water Board will consider a construction site complete when the conditions of the General Permit, Section II.D have been met. Notice of Termination should be filed by the Contractor via the SMARTS system. The City will allow the Contractor to enter data in SMARTS on the City's behalf.

1.8 QUALITY ASSURANCE

- A. Performance: Perform work in accordance with SWPPP/WPCP. Maintain one copy of document on jobsite.
- B. Quality Control and Assurance: Train all employees and subcontractors in these subjects:
 - 1. Material pollution prevention and control
 - 2. Waste management
 - 3. Non-storm water management
 - 4. Identifying and handling hazardous substances
 - 5. Potential dangers to humans and the environment from spills and leaks or exposure to toxic or hazardous substances
- C. Training Requirements: Training must take place before starting work on this job. New employees must receive the complete training before starting work on this job. Conduct weekly meetings to discuss and reinforce spill prevention and control; material delivery, storage, use, and disposal; waste management; and non-storm water management procedures.

1.9 PRE-INSTALLATION CONFERENCE

- A. Timing: Convene a conference one week prior to commencing work at the site
- B. Attendance: Require attendance of parties directly affecting the work of this Section.
- C. Agenda: Review requirements of the SWPPP/WPCP.

1.10 PERFORMANCE REQUIREMENTS

- A. General: The SWPPP/WPCP is a minimum requirement. Revisions and modifications to the SWPPP/WPCP are acceptable only if they maintain levels of protection equal to or greater than originally specified.

- B. Requirements: Read and be thoroughly familiar with all of the requirements of the SWPPP/WPCP.
- C. Compliance: Inspect and monitor all work and storage areas for compliance with the SWPPP/WPCP prior to any anticipated rain.
- D. Corrective Measures: Complete any and all corrective measures as may be directed by the regulatory agency.
- E. Penalties: Contractor to pay any fees and be liable for any other penalties that may be imposed by the regulatory agency for non-compliance with SWPPP during the course of work.
- F. Costs: Contractor to pay all costs associated with the implementation of the requirements of the SWPPP/WPCP in order to maintain compliance with the Permit. This includes installation of all Housekeeping BMPs, General Site and Material Management BMPs, Inspection requirements, maintenance requirements, sampling, monitoring, reporting and all other requirements specified in the SWPPP/WPCP and as required by the General Permit, local, state and federal regulations.

1.11 MATERIALS:

- A. General: All temporary and permanent storm water pollution prevention facilities, equipment, and materials as required by or as necessary to comply with the SWPPP/WPCP as described in the current California Stormwater Quality Association (CASQA) BMP Handbook.

1.12 STORM WATER POLLUTION PREVENTION PLAN

- A. Plan Preparation and Compliance
 1. The Contractor shall conform to Section 13, Water Pollution Control, of the State Standard Specifications and the General Conditions, Special Conditions, and Technical Specifications.
 2. The Contractor shall prepare a Storm Water Pollution Prevention Plan (SWPPP) and the necessary Project Registration Documents to be digitally filed with the California State Water Resources Control Board (SWRCB) through the Stormwater Multi-Application and Report Tracking System (SMARTS database). The Contractor will be responsible to provide the Permit Registration Documents (PRDs) to the City; the QSD will submit the PRDs for the WDID number through SMARTS. The SWPPP shall be prepared based upon the most current California Stormwater Quality Association (CASQA) standard SWPPP Template. The Contractor shall perform the role of "Qualified SWPPP Developer" (QSD) and shall be responsible for all formal amendments to the SWPPP. The Contractor shall also perform the role of "Qualified SWPPP Practitioner" (QSP) and shall be

- responsible for all field SWPPP implementation, monitoring, sampling, and reporting. The completed SWPPP shall be created by the Contractor as necessary to reflect the necessary sequence and staging of field operations.
3. The SWPPP shall conform to SWRCB Order 2009-0009-DWQ (“The Construction General Permit” or “CGP”), San Francisco Bay Regional Water Quality Control Board Order R2-2009-0074 (“Municipal Regional Stormwater NPDES Permit” or “MRP”), Provisions in Section 13, Water Pollution Control, of the State Standard Specifications, the details, operating procedures, and maintenance guidelines of the California Regional Water Quality Control Board San Francisco Bay Region’s Guidelines for Construction Projects (Guidelines), the California Regional Water Control Board San Francisco Bay Region’s Erosion and Sediment Control Field Manual (Manual), the project plans and the General Conditions, Special Conditions, and Technical Specifications. The SWPPP shall be deemed to fulfill the requirements set forth in Section 13 of the State Standard Specifications for development and submittal of a Water Pollution Control Program.
 4. Prior to the Notice to Proceed (with field activities), the State Project Registration Documents (PRDs) will have been filed digitally through SMARTS, and confirmation from the SWRCB will have been received authorizing coverage of this project under the CGP. Construction cannot commence until a WDID has been received.
- B. Risk Based Contractor Requirements and City Responsibilities (Applicable for all project risk levels/types) – The following minimum items shall be included within the SWPPP, as prepared by the Contractor
1. Risk Level Determination (to be performed by Contractor)
 2. WDID Number (to be obtained by Contractor through coordination with City)
 3. Certification by City “Legally Responsible Party” (LRP) (to be provided by City)
 4. Placeholder for Contractor SWPPP training throughout construction
 5. Name and contact information of Contractor QSD (to be provided by Contractor)
 6. Name and contact information of Contractor QSP (to be provided by Contractor)
 7. Schedule of Construction and Deployment of BMPs for each phase of work (to be provided by Contractor)
 8. Description of minimum year round sediment control measures per Order 2009-009- DWQ
 9. Dates and description of all formal SWPPP amendments (to be prepared by Contractor)
 10. Description of Construction Site Monitoring Plan (CSMP) per Order 2009-009-DWQ (to be done by Contractor) including, but not limited to the following:
 - a. Sampling preparation,
 - b. Collection,
 - c. Quality assurance and quality control,

- d. Sample labeling,
 - e. Collection documentation,
 - f. Sample shipping,
 - g. Chain of custody,
 - h. Sample numbering,
 - i. Precautions from the construction site health and safety plan, and
 - j. Providing and maintaining a function rain gauge at all times.
11. Minimum required monitoring activities:
 - a. Post storm event (0.5" or greater) visual discharge inspection (within 48 hours).
 - b. Sampling for non-visible pollutants:
 - Take one or more sample during any breach, spill, malfunction, or leakage that could discharge non visible pollutants into storm-water.
 - Samples taken must be large enough to accurately categorize site conditions.
 - Samples taken must be within the first 2 hours of rain events that occur during scheduled business hours that produce runoff.
 - Samples shall be analyzed for pollutants in accordance with warrant as necessary for protection of surface waters.
 - An uncontaminated (control) sample must be taken as a basis of comparison.
 - Samples must be received by the laboratory within 48 hours of physical sampling. The Contractor must use containers provided by the laboratory.
 - c. Quarterly inspections for non-stormwater discharges.
 12. Minimum scheduled BMP inspections with appropriate documentation:
 - a. Weekly, on a year round basis, throughout the duration of construction.
 - b. Daily (once every 24 hours) BMP inspection during extended storm events.
 - c. Inspect drainage areas and BMPs within 48 hours of predicted rainfall event (0.5" or greater).
 13. Intent of compliance with the following analytical methods and sampling protocol:
 - a. Standard Methods for the Examination of Water and Wastewater (American Public Health Association).
 - b. 40 CFR Part 136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants."
 - c. Surface Water Ambient Monitoring Program's (SWAMP) 2008 Quality Assurance Program Plan.
 14. Potential sources of non-visible pollutants
 15. Description of all minimum source control measures, "good housekeeping", and non stormwater management per Order 2009-009-DWQ
 16. Other measures as necessary for Order 2009-009-DWQ

- C. Risk Based Contractor Requirements and City Responsibilities (Applicable to Risk Level 2/LUP Type 2 or higher)
1. All requirements for Risk Level 1/Type 1 above
 2. Description of applicable Numeric Action Levels for pH and turbidity (to be included in SWPPP by Contractor)
 - a. pH –levels must be maintained within a range of 6.5-8.5.
 - b. Turbidity – 250 NTU maximum.
 3. Description of additional provisions within the CSMP for stormwater effluent monitoring and reporting and non-stormwater discharges (to be included within SWPPP by Contractor):
 - a. Numeric Action Level (NAL) sampling:
 - Water quality grab samples shall be taken at a minimum 3 times a day during each rain event of ½ an inch or more, where runoff occurs. The grab samples shall be representative of the flow and characteristic of the discharges. The contractor shall forward grab sampling results to the City within 24 hours of when they are taken.
 - All discharge points must be sampled, including the one considered to be the “worst case.” Discharge from a silt fence or sheet flow area shall be considered one discharge point.
 - All points of run on. A sheet flow area shall be considered one point of run on.
 - Sampling to comply with analytical methods and protocol described in EPA Test Method 180.1.or Standard Method 2130 for turbidity sampling, ASTM D1293- 99(2005) for pH sampling, and Standard Methods for the Examination of Water and Wastewater (American Public Health Association).
 - c. Sampling for non-stormwater discharges.
 4. Description of requirement to create and implement of “Rain Event Action Plans” for each of the following phases of construction (REAPs to be prepared by Contractor’s QSP):
 - a. Grading and Land Development,
 - b. Streets and Utilities,
 - c. Vertical Construction,
 - d. Final Landscaping and Stabilization,
 - e. Inactive Construction Status.
 - f. The Contractor shall create and implement Rainfall Event Action Plans for inclusion within approved SWPPP at least 48 hours prior to any likely (forecast by National Weather Service as 50% or greater chance) precipitation event.
 5. Description of year round effective erosion control measures to supplement minimum sediment control measures within active, inactive, and completed areas. Erosion control measures shall be provided to the extent necessary for compliance with Order 2009-009- DWQ.

6. Description of additional Annual Reporting Requirements (Annual reporting information to be prepared by Contractor for review and approval of City prior to submittal):
 - a. Creation and submittal of NAL exceedance reports, if applicable,
 - b. Creation and submittal of sampling logs for pH and turbidity.

- D. Risk Based Contractor Requirements and City Responsibilities (Applicable to Risk Level 3/LUP Type 3 only)
 1. All requirements for Risk Level 2 projects described above.
 2. Description of Required Compliance with State Board criteria for technology-based numeric effluent limitations for discharge of pH and turbidity (Description of requirements and physical achievement provided by Contractor):
 - a. For Projects that employ Advanced Treatment Systems (ATS) - Maximum 10 NTU Daily Weighted Average & Maximum 20 NTU for any single sample, applicable for events up to 24 hour events of ½ inches¹. The ATS system must be able to treat this volume within a maximum 72-hour period.
 - b. For Projects that do not employ ATS - Maximum 500 NTU for any single sample, applicable for events up to 24 hour events up to ½ inches².
 - c. Project discharges must maintain pH within a range of 6.0 to 9.0.
 3. Description of additional provisions within the CSMP (description of monitoring provided by Contractor, additional monitoring performed by Contractor):
 - a. Receiving water monitoring, if applicable, based upon the standards of Order 2009- 009-DWQ.
 - b. Bioassessment, if applicable, based upon the standards of Order 2009-009-DWQ.
 - c. Sampling for Suspended Sediment Concentration, if applicable, based upon the standards of Order 2009-009-DWQ. Sampling to comply with analytical methods and protocol described within ASTM Designation: D 3977 for suspended sediment concentration (SSC).
 - d. Inspection of ATS facilities, if applicable. Sampling of ATS discharge points.
 4. Placeholder for Creation of ATS Plan, if applicable, consisting of the following (to be provided by Contractor):
 - a. ATS Operation and Maintenance Manual for All Equipment.
 - b. ATS Monitoring, Sampling & Reporting Plan, including Quality Assurance/Quality Control (QA/QC).
 - c. ATS Health and Safety Plan.
 - d. ATS Spill Prevention Plan.

5. Description of Additional annual reporting requirements (Description provided by Contractor, Annual Reporting information to be prepared by Contractor for review and approval of City)
 - a. Creation and submittal of NEL violation reports, if applicable within 6 hours of occurrence. Reports and related corrective action measures to be reviewed and approved by City prior to submittal to Regional Board
 - b. Completed ATS records, if applicable.

PART 2 - PRODUCTS

2.1 BEST MANAGEMENT PRACTICE (BMP) PRODUCTS

- A. Shall be as specified in the most current CASQA BMP Handbook.
- B. SWPPP as prepared by Qualified SWPPP Developer (QSD)
- C. Risk Level Determination
- D. Notice of Intent/Notice of Substantial Completion
- E. Shall include but is not limited to sampling, reports and other miscellaneous items as determined by the State of California and all pertaining regional and local permits.

PART 3 - EXECUTION

3.1 EROSION AND SEDIMENTATION CONTROL

- A. Temporary erosion and sediment control work shall consist of applying erosion control materials to embankment slopes, excavation slopes and other areas designated on the plans, installing silt fence, inlet protection, gravel bags, headwall protection and stabilized construction entrance ways, or other measures as specified in the project SWPPP/WPCP or necessary for compliance with the CGP.
- B. All temporary erosion and sediment control for the project shall conform to the provisions in Section 13, Water Pollution Control, of the State Standard Specifications and the General Conditions, Special Conditions, and Technical Specifications. All permanent erosion and sediment control for the project shall conform to the provision in Section 21, Erosion Control, of the State Standard Specifications and the General Conditions, Special Conditions, and Technical Specifications.

3.2 INSTALLATION

A. Construction Requirements

1. The Contractor shall design, implement and maintain the SWPPP/WPCP for the project in full compliance with the SWRCB Order 2009-009-DWQ to control the discharge of storm water pollutants. The Contractor shall perform the monitoring and reporting required to comply with all the state regulations regarding the SWPPP/WPCP for the project. All monitoring, sampling, and reporting information collected by the Contractor shall be subject to the review of the City prior to uploading through the SMARTS database.

B. Storm Water Pollution Prevention Plan and Water Pollution Control Plan

1. The SWPPP/WPCP shall identify construction activities that may adversely affect the quality of storm water discharges associated with the project and shall identify water pollution control measures, hereinafter referred to as control measures, to be constructed, implemented, and maintained in order to reduce, to the maximum extent feasible, storm water discharges from the construction site both during and after construction is completed under this contract.
2. The Contractor's "QSD" shall amend the SWPPP/WPCP, graphically and in narrative form, whenever there is a change in construction activities or operations which may affect the discharge of significant quantities of pollutants to surface waters, ground waters, municipal storm drain systems, whenever there is a change in disturbed area, and/or or when deemed necessary by the City. The SWPPP/WPCP shall be amended if, at any time, the implementation of the SWPPP/WPCP is not effectively achieving the objective of compliance with the CGP. Amendments shall show additional control measures or revised operations, including those in areas not shown in the initial SWPPP/WPCP, which are required on the project to control water pollution effectively. Amendments to the SWPPP/WPCP shall be closely coordinated with the Contractor's Qualified SWPPP Practitioner (QSP) within five (5) working days. In emergency situations that require immediate changes at the project site, the Contractor's QSP shall implement the necessary measures and notify the Project Manager and Contractor's QSD of the changes.
3. The Contractor shall give immediate notice to the Project Manager of any planned changes in construction activity that may result in non-compliance with the General Conditions, Special Conditions, and Technical Specifications or the CGP.
4. By the last day of each month, the Contractor shall submit an affidavit to the Project Manager certifying conformance with the SWPPP/WPCP. The monthly partial payment may be withheld if the affidavit is not received and accepted by the Project Manager. If at any time the project is in non-compliance with the SWPPP/WPCP or the CGP, the Contractor shall submit a written report to the Project Manager immediately upon identifying the

non-compliance. The report shall specify the time and nature of the non-compliance and include a course of action to correct the deficiency.

5. The Contractor shall keep a copy of the State of California Construction Activity General Permit (SWRCB Order No. 2009-009-DWQ), the SWPPP/WPCP, and any approved amendments at the project site. The SWPPP/WPCP shall be made available upon request of any representative of the Regional Water Quality Control Board, State Water Resources Control Board, United States Environmental Protection Agency, or any City representative. Public requests for copies of the SWPPP/WPCP shall be directed to the Project Manager.

C. Erosion and Sediment Control

1. The facilities shown on the SWPPP/WPCP are designed to effectively control erosion and sediment on a year-round basis.
 - a. Construction operations shall be carried out in such a manner that erosion and water pollution will be minimized. Contractor shall comply with state and local laws concerning pollution abatement.
 - b. Contractor shall be responsible for monitoring erosion and sediment control measures prior, during, and after storm events. Monitoring and sampling (as applicable) shall follow the protocol described in the CGP and Project SWPPP/WPCP.
 - a. Extreme care shall be taken when hauling any earth, sand, gravel, stone, debris, paper, or any other substance over any public street, alley or other public place. Occurrences of material blown, spilled, or tracked over and upon said public or adjacent private property are prohibited and shall be immediately remedied. Discharge of debris is prohibited. Non-stormwater discharge is prohibited, except as specified in SWRCB Order 2009-009-DWQ. Discharge of hazardous substances is prohibited.
 - b. Inlet protection shall be installed at open inlets to prevent sediment from entering the storm drain system. Inlets not used in conjunction with erosion control are to be blocked to prevent entry of sediment.
 - c. All paved areas shall be kept clear of earth material and debris. The site shall be maintained so as to prevent sediment-laden runoff to any storm drainage system, including existing drainage swales and watercourse, to the extent necessary for compliance with applicable numeric action or effluent levels specified in the CGP and Project SWPPP/WPCP.
 - d. Contractor shall install and maintain construction entrances prior to commencement of grading. All construction vehicle traffic entering onto the paved roads must cross stabilized construction entrance ways. Entrance ways may be constructed of two inch to six-inch drain rock, metal grating, or metal cattle-guard, or equivalent material, or may include vehicle wash stations as needed, in sufficient quantity and size to prevent tracking of mud and debris from the construction site. Tracking of mud or debris onto public streets, or onto adjacent public

- or private property, is prohibited and shall be removed immediately as required by the City.
- e. Grading operations which leave denuded slopes shall be protected with erosion control measures within 14 days of completion or suspension of activity. If hydroseeding is not used or is not effective within this 14-day period, then other immediate methods shall be implemented, such as erosion control blankets, blown straw, or a three step application of 1) seed, mulch, fertilizer, 2) blown straw, and 3) tackifier and mulch.
 - f. Sanitary facilities shall be maintained on the site in a manner to prevent inadvertent discharge or leakage of sanitary wastes into the storm drain system either by placing sanitary facilities in locations that do not drain to the storm drain system or by providing secondary containment systems to capture leaked wastes.
 - g. Contractor shall provide dust control as required by the appropriate federal, state and City requirements and the City Standard Specifications.
 - h. The erosion and sediment control plan may not cover all the situations that may arise during construction due to unanticipated field conditions. Variations and additions may be made to the plan in the field. That Contractor's QSP shall notify the Contractor's QSD of any field changes.
- D. Maintenance: The SWPPP/WPCP shall include a plan for maintenance that shall include at a minimum.
1. Immediate repair of damage caused by soil erosion or construction.
 2. Inspection of sediment traps, berms, rills, gullies, and swales before, during, and after each storm event or predicted rainfall in accordance with the CGP and project SWPPP/WPCP. This also includes repair or cleaning as needed.
 3. Removal of sediment from sediment traps and restoration to original dimensions when sediment has accumulated to a depth of one foot. Sediment removed from trap shall be deposited in a suitable area and in such a manner that it will not erode.
 4. Regular cleaning of gravel bag inlet protection so that sediment depth never exceeds a maximum of three inches.
- E. Risk Based Contractor Requirements and City Responsibilities (Applicable for all project risk levels/types) – The following minimum items shall be performed by the Contractor during field implementation of the Project SWPPP/WPCP throughout the duration of construction until final Notice of Termination
1. Coordinate and conduct periodic SWPPP/WPCP and Erosion and Sediment Control training throughout construction
 2. Update schedule of construction and deployment of BMPs for each phase of work on an as-needed basis
 3. Physically install and maintain minimum year-round sediment control measures per Order 2009-009-DWQ

4. Perform and file all formal SWPPP/WPCP amendments. All SWPPP/WPCP amendments to be reviewed and approved by the City and the Contractor's QSD prior to submittal.
5. Physically perform and implement all measures found within the SWPPP/WPCP Construction Site Monitoring Plan (CSMP) per Order 2009-009-DWQ including, but not limited to the following:
 - a. Sampling preparation,
 - b. Collection,
 - c. Quality assurance and quality control,
 - d. Sample labeling,
 - e. Collection documentation,
 - f. Sample shipping,
 - g. Chain of custody,
 - h. Sample numbering,
 - i. Precautions from the construction site health and safety plan, and
 - j. Providing and maintaining a function rain gauge at all times.
6. Minimum required monitoring activities:
 - a. Post storm event (0.5" or greater) visual discharge inspection (within 48 hours).
7. Sampling for non-visible pollutants:
 - a. Take one or more sample during any breach, spill, malfunction, or leakage that could discharge nonvisible pollutants into stormwater.
 - Samples taken must be large enough to accurately categorize site conditions.
 - Samples taken must be within the first 2 hours of rain events that occur during scheduled business hours that produce runoff.
 - Samples shall be analyzed for pollutants in accordance with an appropriate pollutant source assessment, or as conditions warrant as necessary for protection of surface waters.
 - An uncontaminated (control) sample must be taken as a basis of comparison.
 - Samples must be received by the laboratory within 48 hours of physical sampling. The Contractor must use containers provided by the laboratory.
 - b. Quarterly inspections for non-stormwater discharges.
8. Minimum scheduled BMP inspections with appropriate documentation:
 - a. Weekly, on a year-round basis, throughout the duration of construction.
 - b. Daily (once every 24 hours) BMP inspection during extended storm events.
 - c. Inspect drainage areas and BMPs within 48 hours of predicted rainfall event (0.5" or greater).
9. Compliance with the following analytical methods and sampling protocol:
 - a. Standard Methods for the Examination of Water and Wastewater

- (American Public Health Association).
 - b. 40 CFR Part 136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants."
 - c. Surface Water Ambient Monitoring Program's (SWAMP) 2008 Quality Assurance Program Plan.
10. Identify and eliminate potential sources of non-visible pollutants
 11. Implementation of all minimum source control measures, "good housekeeping", and non-stormwater management per Order 2009-009-DWQ
 12. Other measures as necessary for Order 2009-009-DWQ
- F. Risk Based Contractor Requirements and City Responsibilities (Applicable to Risk Level 2/LUP Type 2 or higher)
1. All requirements for Risk Level 1/Type 1 above
 2. Maintain tolerance of site discharge within applicable Numeric Action Levels for pH and turbidity
 - a. pH –levels must be maintained within a range of 6.5-8.5.
 - b. Turbidity – 250 NTU maximum.
 3. Numeric Action Level (NAL) sampling:
 - a. Water quality grab samples shall be taken at a minimum 3 times a day during each rain event of ½ an inch or more, where runoff occurs. The grab samples shall be representative of the flow and characteristic of the discharges. The contractor shall forward grab sampling results to the City within 24 hours of when they are taken.
 - b. All discharge points must be sampled, including the one considered to be the "worst case." Discharge from a silt fence or sheet flow area shall be considered one discharge point.
 - c. All points of run on. A sheet flow area shall be considered one point of run on.
 - d. Sampling to comply with analytical methods and protocol described in EPA Test Method 180.1 or Standard Method 2130 for turbidity sampling, ASTM D1293- 99(2005) for pH sampling, and Standard Methods for the Examination of Water and Wastewater (American Public Health Association).
 4. Sampling for non-stormwater discharges
 5. Create and physically implement of "Rain Event Action Plans" for each of the following phases of construction:
 - a. Grading and Land Development,
 - b. Streets and Utilities,
 - c. Vertical Construction,
 - d. Final Landscaping and Stabilization,
 - e. Inactive Construction Status.

6. The Contractor shall create and implement Rainfall Event Action Plans for inclusion within approved SWPPP/WPCP at least 48 hours prior to any likely (forecast by National Weather Service as 50% or greater chance) precipitation event.
 7. Physically implement and maintain year-round effective erosion control measures to supplement minimum sediment control measures within active, inactive, and completed areas. Erosion control measures shall be provided to the extent necessary for compliance with Order 2009-009-DWQ.
 8. Maintain and compile documents to meet Annual Reporting Requirements (Annual reporting information to be prepared by Contractor for review and approval of City prior to submittal):
 - a. Creation and submittal of NAL exceedance reports within 48 hours, if applicable, based upon review and approval of City.
 - b. Creation and submittal of sampling logs for pH and turbidity.
- G. Risk Based Contractor Requirements and City Responsibilities (Applicable to Risk Level 3/LUP Type 3 only)
1. All requirements for Risk Level 2 projects described above.
 2. Maintain physical compliance with State Board criteria for technology-based numeric effluent limitations for discharge of pH and turbidity
 3. For Projects that employ Advanced Treatment Systems (ATS) - Maximum 10 NTU Daily Weighted Average & Maximum 20 NTU for any single sample, applicable for events up to 24-hour events of ½ inches³. The ATS system must be able to treat this volume within a maximum 72-hour period.
 4. For Projects that do not employ ATS - Maximum 500 NTU for any single sample, applicable for events up to 24-hour events up to ½ inches⁴.
 5. Project discharges must maintain pH within a range of 6.0 to 9.0.
 6. Perform additional provisions within the CSMP:
 - a. Receiving water monitoring, if applicable, based upon the standards of Order 2009- 009-DWQ.
 - b. Bioassessment, if applicable, based upon the standards of Order 2009-009-DWQ.
 - c. Sampling for Suspended Sediment Concentration, if applicable, based upon the standards of Order 2009-009-DWQ. Sampling to comply with analytical methods and protocol described within ASTM Designation: D 3977 for suspended sediment concentration
 - d. Inspection of ATS facilities, if applicable. Sampling of ATS discharge points.
 7. Creation and implementation of ATS Plan, if applicable, consisting of the following:
 - a. ATS Operation and Maintenance Manual for All Equipment.
 - b. ATS Monitoring, Sampling & Reporting Plan, including Quality Assurance/Quality Control (QA/QC).
 - c. ATS Health and Safety Plan.

- d. ATS Spill Prevention Plan.
8. Maintain and compile additional annual reporting requirements (Annual Reporting information to be prepared by Contractor for review and approval of City prior to submittal)
- a. Creation and submittal of NEL violation reports, if applicable within 6 hours of occurrence. Reports and related corrective action measures to be reviewed and approved by City prior to submittal to Regional Board
 - b. Completed ATS records, if applicable.

3.3 STREET SWEEPING

- A. Street sweeping: Street sweeping will be implemented everywhere where sediment is tracked from the project site onto public roads. Sweeping will be done during all construction activities to control tracking of sediments as required as per the guidelines provided in the SWPPP document and as directed in this section.

3.4 DUST CONTROL

- A. Contractor's Responsibility: Use equipment that will generate the least amount of dust. Provide dust control at all times including Saturdays, Sundays, and holidays as ordered by the Project Manager. Whenever the Contractor, in the opinion of the Project Manager, is negligent in controlling dust, the Project Manager may direct attention to the existence of a dust hazard and instruct the Contractor to immediately alleviate the dust hazard. The Contractor shall be responsible for any damage cause by dust generated as a result of its operations.
- B. Street Vacuum/Sweeper: Have a commercial standard street vacuum/sweeper operational and in operation during each working day. The street vacuum/sweeper shall be able to pick up sand, gravel, dust, and debris, and other things, shall minimize dust generation, and shall also be available during the day and shall sweep as outlined below and as directed by the Project Manager.
- C. Sweeping: If the Contractor is performing work that generates dust and debris then during the day (including weekends and holidays) the sweeper shall sweep the project area (full length, width, and all lanes) twice a day sometime between 9:00a.m. and 11:00a.m. and also between 2:00p.m. and 4:00p.m. Hardscape surfaces (including pavers, sidewalks, and areas inaccessible by a mechanical sweeper) shall have dirt, dust, and debris removed by hand sweeping. If the Contractor fails to fulfill the responsibilities of this Section the City will perform or contract with others to perform the work and all costs incurred to the City shall be withheld from future payments to the Contractor.

- D. Additional Sweeping: Clean the sidewalk and gutter as many times as needed to make sure the sidewalk and gutter are out of dirt, debris and small rocks at all times. Be prepared to sweep surfaces immediately at the request of the Project Manager should it be deemed necessary for public safety and to avoid damage to properties. If streets are not satisfactorily cleaned within 12 hours from verbal or written notice by City personnel, the City will hire an independent sweeping company and deduct the cost for such work from payments due to the Contractor.
- E. Payment for Dust Control and Clean Up: Shall be included in the prices paid for Storm Water Pollution Prevention Plan (SWPPP) or Water Pollution Control Plan (WCPC) as shown in the Bid Schedule or considered incidental to the items most closely related to when there is no bid item. This Item shall be considered as full compensation for all labor, materials, tools, equipment and incidentals and for doing the work of Dust Control and Clean Up and no additional compensation shall be made therefor.

3.5 EMERGENCY EROSION AND SEDIMENT CONTROL

- A. Shall consist of any measures not addressed in the SWPPP/WPCP that the Project Manager or QSD deems necessary for compliance with the CGP including, but not limited to all erosion control measures necessary to prevent degradation to water quality.
- B. Sediment Control including unforeseen measures not addressed in the Storm Water Pollution Plan pay item in accordance with the National Pollution Discharge Elimination System (NPDES), the City of Pittsburg and the Plans and Specifications and to the satisfaction of the Project Manager. Work under this item shall be considered as extra work paid for on a force account basis.

END OF SECTION 01 57 23

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SECTION 01 60 00 – PRODUCT REQUIREMENTS**PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes administrative and procedural requirements governing the Contractor's selection of products for use in the Project.

1.2 DEFINITIONS

- A. Products:
 - 1. General: Items purchased for incorporation in the Work, whether purchased for the Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 - 2. Named Products: Items identified by the manufacturer's product name, including make or model number or other designation, shown or listed in the manufacturer's published product literature, that is current as of the date of the Contract Documents.
 - 3. Materials: Components shaped, cut, worked, mixed, finished, refined or otherwise fabricated, processed, or installed to form a part of the Work.
 - 4. Equipment: Product with operational parts, whether motorized or manually operated, that requires service connections, such as wiring or piping.

1.3 QUALITY ASSURANCE

- A. Source Limitations: To the fullest extent possible, provide products of the same kind from a single source.
- B. Compatibility of Options: When the Contractor is given the option of selecting between 2 or more products for use on the Project, the product selected shall be compatible with products previously selected, even if previously selected products were also options.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. General: Deliver, store, and handle products according to the manufacturer's recommendations, using means and methods that will prevent damage, deterioration, and loss, including theft.
 - 1. Schedule delivery to minimize long-term storage at the site and to prevent overcrowding of construction spaces.
 - 2. Coordinate delivery with installation time to assure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.

3. Deliver products to the site in an undamaged condition in the manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products upon delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
5. Store products at the site in a manner that will facilitate inspection and measurement of quantity or counting of units.
6. Store heavy materials away from the Project structure in a manner that will not endanger the supporting construction.
7. Store products subject to damage by the elements above ground, under cover in a weathertight enclosure, with ventilation adequate to prevent condensation. Maintain temperature and humidity within range required by manufacturer's instructions.

PART 2 - PRODUCTS

2.1 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only: Products complying with specified reference standards or description.
- B. Products Specified by Naming One or More Manufacturers: Products of one of manufacturers named and complying with Specifications; no options or substitutions allowed.
- C. Products Specified by Naming One or More Manufacturers with Provision for Substitutions: Submit Request for Substitution for any manufacturer not named, according to [Section 01 25 00 - Substitution Procedures](#).

PART 3 - EXECUTION

3.1 INSTALLATION OF PRODUCTS:

- A. General: Refer to [Section 01 70 00 – Execution](#).
- B. Product Handling: Assure that Work is manufactured and/or fabricated in ample time to not delay construction progress. Transport, handle, store and protect products in accordance with manufacturer's instructions.

END OF SECTION 01 60 00

SECTION 01 61 20

SEISMIC DESIGN CRITERIA

PART 1 - GENERAL

1.01 SUMMARY

- A. Designated components to be furnished under this Contract shall be designed, constructed, and installed in conformance with the seismic requirements of the 2022 California Building Code (CBC) and American Society of Civil Engineers (ASCE) 7, and the following seismic design parameters:
1. Risk Category: IV
 2. Mapped Spectral Response Acceleration for Short Period (S_s) = 1.88g
 3. Mapped Spectral Response Acceleration for 1-second Period (S_1) = 0.64g
 4. Site Class: C
 5. Design Spectral Response Acceleration for Short Period (S_{DS}) = 1.50g
 6. Design Spectral Response Acceleration for 1-second Period (S_{D1}) = 0.60g
 7. Seismic Design Category D
 8. $I_E = 1.5$ for entire structure
 9. $I_P = 1.0$ for nonstructural components and equipment, unless otherwise noted.
 10. $I_P = 1.5$ where required by Code and for the following nonstructural components and equipment:
 - a. Components required to function for life-safety purposes after an earthquake, including all fire protection sprinkler systems and egress stairways
 - b. Components conveying, supporting, or otherwise supporting hazardous substances and are attached to areas classified as H-4 Occupancy.
 - c. All other nonstructural components or equipment identified in these Specifications as requiring $I_P = 1.5$
- B. Seismic anchorage calculations shall be provided for all components except those with an operating weight less than 400 pounds and mounted 4 feet or less above floor level. However, calculation-exempted components shall still meet all anchorage requirements set forth in ASCE 7 and this Section.
- C. A Certificate of Compliance from the equipment manufacturer shall be provided where required in these Technical Specifications and/or Drawings demonstrating the equipment and its components can withstand the design earthquake ground motion and remain operable.

1.02 RELATED SECTIONS

- A. Section 01 61 40 – Wind Design Criteria
- B. Section 40 05 07 – Pipe Hangers and Supports

1.03 SUBMITTALS

- A. Submit calculations and/or shop drawings, in accordance with Division 1, including the information below.

- B. Design Data:
 - 1. Anchorage System – Contractor shall submit, for review and approval, structural calculations of the proposed anchorage system, prepared, sealed, and signed by a Professional Civil or Structural Engineer licensed in the State of California.
- C. Certification:
 - 1. Submit a Certificate of Compliance from the equipment or component manufacturer for Designated Seismic Systems identified in these Technical Specifications and/or Drawings. Certifications shall be sealed and signed by a Professional Civil or Structural Engineer licensed in the State of California.

1.04 REFERENCE STANDARDS

- A. California Building Standards Commission (CBSC)
 - 1. California Building Code (CBC)
- B. American Society of Civil Engineers (ASCE)
 - 1. ASCE/SEI 7, Minimum Design Loads and Associated Criteria for Buildings and Other Structures
- C. American Concrete Institute (ACI)
 - 1. ACI 318, Building Code Requirements for Structural Concrete
- D. International Code Council Evaluation Services (ICC-ES)
 - 1. Manufacturer Evaluation Reports, as appropriate
- E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
 - 1. Seismic Restraint Manual – Guidelines for Mechanical Systems
- F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 SEISMIC CERTIFICATION

- A. The manufacturer of each Designated Seismic System subject to the provisions of ASCE 7, Section 13.2.2 shall test or analyze the components and its mounting system or anchorage and submit a Certificate of Compliance for review and acceptance by the Engineer.
 - 1. Active mechanical and electrical equipment that must remain operable following the design earthquake ground motion shall be certified by the manufacturer as operable whereby active parts or energized components shall be certified exclusively on the basis of approved shake table testing or experience data in accordance with ASCE 7.
 - 2. Components with hazardous substances and assigned a component importance factor $I_P = 1.5$ shall be certified by the manufacturer as maintaining containment following the design earthquake motion by (1) analysis, (2) approved shake table testing, or (3) experience data in accordance with ASCE 7.

1.06 FIXTURE AND EQUIPMENT ANCHORAGE

- A. Anchorage and other supports for all equipment where specified in these Technical Specifications shall be designed to resist seismic forces occurring at each of the three principal directions separately as well as simultaneously.

- B. Structural design calculations for equipment anchorage and other elements as required shall be sealed by a Professional Civil or Structural Engineer licensed in the State of California.
- C. Mechanical and electrical components, equipment housings and their attachments, supporting structures, and anchorage shall be as follows:
 - 1. These elements shall be designed and constructed to resist the seismic forces in accordance with Chapter 16 of the CBC. This force shall be considered acting at the center of gravity of the piece under consideration. No equipment shall be anchored to vertical structural elements without written approval of the Engineer.
 - 2. Vibration-isolated equipment shall be provided with snubbers capable of retaining the equipment in its designated location without any material failure or deformation of the snubbers when exposed to a vertical or horizontal force at the contact surface equal to 100 percent of the operating weight of the equipment. Air gaps between retainers and equipment shall not exceed 1/4 inch.
 - 3. Piping with flexible connections and/or expansion joints shall be anchored such that the intended uses of these joints are maintained in the piping system.
 - 4. Calculations and shop drawings shall be submitted for all anchorage details. All calculations shall be prepared and signed by a Professional Civil or Structural Engineer licensed in the State of California. Inasmuch as all anchorage of equipment is to be made of poured-in-place concrete elements, it is imperative that types of anchorage be coordinated with the concrete contractor so that anchorage may be installed at time of concrete placement.
- D. Cast-in anchor bolts are preferred for support of critical equipment and framing. Post-installed concrete anchors (expansion or adhesive) will not be used, without approval from the Engineer, for critical fastening such as extreme vibratory conditions, impact loads, seismic connections, and overhead installations.
- E. Post-installed concrete anchors, including expansion and adhesive anchors, shall have a current evaluation report issued by ICC-ES. Design values and installation requirements for anchors will be as presented in the ICC-ES ESR (Evaluation Services Report) for the anchor. Edge distance, bolt spacing, inspection requirements and operating temperatures shall be considered when determining the appropriate design values. The ICC-ES ESR shall indicate the anchors can be used to resist seismic loads in cracked concrete.
- F. Do not use friction to resist seismic forces.

1.07 VIBRATION ISOLATION

- A. In general, equipment should be rigidly mounted to supporting foundations and structures, without the aid of vibration isolation devices. Exceptions are mechanical equipment in which vibrations transmitted from the equipment would be troubling to building occupants and/or other equipment within the building.
- B. If vibration-isolation mountings are required for equipment, the mountings, and their attachments to the supporting structure, shall be designed as flexible mountings in accordance with governing Code. The supplier of the vibration isolation mounting hardware shall be required to submit certified calculations, sealed by a Professional Civil or Structural Engineer licensed in the State of California, indicating the adequacy of the hardware and attachment anchorage to meet these criteria.

1.08 ABOVEGROUND PIPING

- A. See Section 40 05 07, Pipe Hangers and Supports.

- B. Piping crossing expansion joints between adjacent structures shall be provided with expansion fittings, multiple bends, or other suitable provisions to ensure capacity to sustain expected differential movement between structures.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL

- A. All equipment designed to be fixed in position shall be securely fastened in place in conformance with the CBC, ASCE 7, or as specified in the Technical Specifications for a specific piece of equipment under Division 2 through 16. For other equipment, the equipment manufacturer shall provide recommended anchorage information to the Contractor for use in the installation of the equipment.
- B. See also Section 01 61 40 for Wind Design Criteria.

3.02 STRUCTURAL INTEGRITY AND ANCHORAGE

- A. It shall be the responsibility of the equipment manufacturer/supplier to provide the engineering anchorage calculations and figures to the Contractor for submission to the Engineer. As a minimum, the equipment manufacturer/supplier shall determine the number, dimensions, and material, location, embedment, and installation conditions of all anchor bolts to be set in concrete in accordance with Technical Specifications and/or Drawings. At the option of the Contractor, the Contractor or equipment manufacturer/supplier shall furnish the anchor bolts and associated hardware as specified herein and as determined by the manufacturer/supplier's engineering anchorage calculations for installation by the Contractor.
- B. Engineering anchorage calculations and figures shall be prepared, stamped, and signed by a Professional Civil or Structural Engineer licensed in the State of California. Calculations shall include the following steps as a minimum:
 - 1. Determine the operating equipment weight and centroid of the equipment.
 - 2. Determine the shear and overturning forces at each anchor due to the force determined, as specified below, being applied at the equipment's centroid.
 - 3. Determine the shear and tension forces that must be developed by the anchor at each support to resist the forces calculated.
 - 4. Select the anchorage details based upon the maximum shear and tension forces calculated above. As a minimum, details shall include number of bolts, materials, diameter, total length, embedded length, required edge distance, and bolt dimensions.
- C. For all equipment weighing 400 pounds or more, the minimum cast-in-place anchor bolt size shall be 5/8 inch in diameter, with 5 inches minimum embedment. The minimum cast-in-place anchor bolt size for all other equipment shall be 3/8 inch in diameter, with 3 inches minimum embedment. All anchor bolts securing equipment to be grouted shall be furnished with leveling nuts, the faces of which shall be tightened against the flat surfaces to not less than 10 percent of the bolt's safe tensile stress.
- D. Cast-in-place anchor bolts shall be set before concrete has been placed and shall be carefully held in position with anchor bolt setting templates.
- E. No equipment shall be anchored to vertical structural elements without the written approval of the Engineer, with the exception of pipe hangers/supports or anchorage as specified.

END OF SECTION

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SECTION 01 61 40

WIND DESIGN CRITERIA

PART 1 - GENERAL

1.01 SUMMARY

- A. Designated components to be furnished under this Contract shall be designed, constructed, and installed in conformance with the wind design requirements of the 2019 California Building Code (CBC) and American Society of Civil Engineers (ASCE) 7, and the following wind design parameters:
 - 1. Risk Category, IV
 - 2. Ultimate Design Wind Speed, V_{ult} (3-second gust): 103 miles per hour
 - 3. Wind Exposure Category "C"

1.02 RELATED SECTION

- A. Section 01 61 20 – Seismic Design Criteria

1.03 SUBMITTALS

- A. Submit calculations and/or shop drawings, in accordance with Division 1, including the information below.
- B. Design Data:
 - 1. Anchorage System – Contractor shall submit, for review and approval, structural calculations of the proposed anchorage system, prepared, sealed, and signed by a Professional Civil or Structural Engineer licensed in the State of California

1.04 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. California Building Standards Commission (CBSC)
 - 1. California Building Code (CBC)
- B. American Society of Civil Engineers (ASCE)
 - 1. ASCE/SEI 7, Minimum Design Loads and Associated Criteria for Buildings and Other Structures
- C. American Concrete Institute (ACI)
 - 1. ACI 318, Building Code Requirements for Structural Concrete
- D. International Code Council Evaluation Services (ICC-ES)
 - 1. Manufacturer Evaluation Reports, as appropriate.
- E. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 FIXTURE AND EQUIPMENT ANCHORAGE

- A. Anchorage and other supports for all important equipment shall be designed to resist wind forces occurring along each of the three principal directions.
- B. Selected architectural elements (e.g., storefront systems), sunshade structures, exterior mechanical and electrical components, equipment housings and their attachments, supporting structures, and anchorage shall be as follows:

1. Calculations and shop drawings shall be submitted for all anchorage details. All calculations shall be prepared and signed by a Professional Civil or Structural Engineer licensed in the State of California. Inasmuch as all anchorage of equipment is to be made of poured-in-place concrete elements, it is imperative that types of anchorage be coordinated with the concrete contractor so that anchorage may be installed at time of concrete placement. If calculations and anchorage details are not submitted prior to placing concrete, the Contractor will become responsible for any strengthening of concrete elements because of superimposed wind loading.
- C. Cast-in anchor bolts are preferred for support of critical equipment and framing. Post-installed concrete anchors (expansion or adhesive) will not be used, without approval from the Engineer.
- D. Post-installed concrete anchors (expansion and adhesive) shall have a current evaluation report issued by ICC-ES. Design values and installation requirements for anchors will be as presented in the ICC-ES ESR (Evaluation Services Report) for the anchor. Edge distance, bolt spacing, inspection requirements, and operating temperatures shall be considered when determining the appropriate design values.
- E. Do not use friction to resist wind forces.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL

- A. All equipment designed to be fixed in position shall be securely fastened in place in conformance with the CBC, ASCE 7, or as specified here in the Technical Specifications for a specific piece of equipment under Division 2 through 16. For other equipment, the equipment manufacturer shall provide recommended anchorage information to the Contractor for use in the installation of the equipment.
- B. See also Section 01 61 20 for Seismic Design Criteria.

3.02 STRUCTURAL INTEGRITY AND ANCHORAGE

- A. It shall be the responsibility of the equipment manufacturer/supplier to provide the engineering anchorage calculations and figures to the Contractor for submission to the Engineer. As a minimum, the equipment manufacturer/supplier shall determine the number, dimensions, material, location, embedment, and installation conditions of all anchor bolts to be set in concrete in accordance with Technical Specifications and/or Drawings. At the option of the Contractor, the Contractor or equipment manufacturer/supplier shall furnish the anchor bolts and associated hardware as specified herein and as determined by the manufacturer/supplier's engineering anchorage calculations for installation by the Contractor.
- B. Engineering anchorage calculations and figures shall be prepared, stamped, and signed by a Professional Civil or Structural Engineer licensed in the State of California. Calculations shall include the following steps as a minimum:
 1. Determination of the shear and overturning forces at each anchor due to the force determined, as specified below, being applied.
 2. Determination of the shear and tension forces that must be developed by the anchor at each support to resist the forces calculated.
 3. Selection of the anchorage details based upon the maximum shear and tension forces calculated above. At a minimum, details shall include number of bolts,

materials, diameter, total length, embedded length, required edge distance, and bolt dimensions.

- C. For all equipment the minimum anchor bolt size shall be 3/8-inch in diameter, with 2 inches minimum embedment. All anchor bolts securing equipment to be grouted shall be furnished with leveling nuts, the faces of which shall be tightened against the flat surfaces to not less than 10 percent of the bolt's safe tensile stress.
- D. Cast-in-place anchor bolts shall be set before concrete has been placed and shall be carefully held in position with suitable templates of an acceptable design.
- E. No equipment shall be anchored to vertical structural elements without the written approval of the Engineer, with the exception of pipe hangers/supports or anchorage as specified.

END OF SECTION

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SECTION 01 70 00 – EXECUTION**PART 1 - GENERAL****1.1 SUMMARY**

- A. This section includes requirements for field engineering, examination, preparation, execution, cleaning, and protecting installed construction.
- B. Field Engineering: Provide such field engineering services as are required for proper completion of the Work including, but not limited to:
 - 1. Establishing and maintaining lines and levels.
 - 2. Structural design of shores, forms, and similar items provided by the Contractor as part of the means and methods of construction.

1.2 QUALITY ASSURANCE

- A. Workers: Use adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specific requirements and the methods needed for proper performance of the work of this Section.

1.3 SUBMITTALS

- A. Comply with [Section 01 33 00 - Submittal Procedures](#).
- B. Upon request of the Project Manager, submit the following:
 - 1. Engineering qualifications of persons proposed to be engaged for field engineering services.
 - 2. Documentation verifying accuracy of field engineering work.
 - 3. Certification, signed by the Contractor's retained field engineer, certifying that elevations and locations of improvements are in conformance with requirements of the Contract Documents. Documentation shall require surveyor's certification stamp.

1.4 REFERENCE POINTS

- A. In addition to the procedures directed by the Contractor for proper performance of the Contractor's responsibilities:
 - 1. Locate and protect control points before starting work on the site.
 - 2. Preserve permanent reference points during progress of the Work.
 - 3. Do not change or relocate reference points or items of the Work without specific approval from the Project Manager.

4. Notify and advise the Project Manager within twenty-four (24) hours when a reference point is lost or destroyed, or requires relocation because of other changes in the Work:
 - a. Upon direction of the Project Manager, require the field engineer to replace reference stakes and/or markers.
 - b. Locate such replacements according to the original survey control.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that existing Site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.
- B. Verify that existing substrate is capable of structural support or attachment of new Work being applied or attached.
- C. Examine and verify specific conditions described in individual Specification Sections.
- D. Verify that utility services are available with correct characteristics and in correct locations.

3.2 PREPARATION

- A. Clean substrate surfaces prior to applying next material or substance according to manufacturer's instructions.
- B. Seal cracks or openings of substrate prior to applying next material or substance.
- C. Apply manufacturer-required or manufacturer-recommended substrate primer, sealer, or conditioner prior to applying new material or substance in contact or bond.

3.3 EXECUTION

- A. Comply with manufacturer's installation instructions, performing each step-in sequence. Maintain one set of manufacturer's installation instructions at Project Site during installation and until completion of construction.
- B. When manufacturer's installation instructions conflict with Contract Documents, request clarification from Project Manager before proceeding.

- C. Verify that field measurements are as indicated on approved Shop Drawings or as instructed by manufacturer.
- D. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.
 - 1. Secure Work true to line and level and within specified tolerances, or if not specified, industry-recognized tolerances.
 - 2. Physically separate products in place, provide electrical insulation, or provide protective coatings to prevent galvanic action or corrosion between dissimilar metals.
 - 3. Exposed Joints: Provide uniform joint width and arrange to obtain best visual effect. Refer questionable visual-effect choices to Project Manager for final decision.
- E. Allow for expansion of materials and/or movement.
- F. Climatic Conditions and Project Status: Install each unit of Work under conditions to ensure best possible results in coordination with entire Project.
 - 1. Isolate each unit of Work from incompatible Work as necessary to prevent deterioration.
 - 2. Coordinate enclosure of Work with required inspections and tests to minimize necessity of uncovering Work for those purposes.
- G. Mounting Heights: Where not indicated, mount individual units of Work at industry recognized standard mounting heights for particular application indicated.
 - 1. Refer questionable mounting heights choices to Project Manager for final decision.
 - 2. Elements Identified as Accessible to Handicapped: Comply with applicable codes and regulations.
- H. Adjust operating products and equipment to ensure smooth and unhindered operation.
- I. Clean and perform maintenance on installed Work as frequently as necessary through remainder of construction period. Lubricate operable components as recommended by manufacturer.

3.4 CLEANING

- A. Maintain Project Site, surrounding areas and public properties free from accumulations of waste, debris, and rubbish, caused by operations.
- B. At completion of Work, remove waste materials, rubbish, tools, equipment, machinery and surplus materials, and clean all sight-exposed surfaces; leave Project Site clean and ready for occupancy.
- C. Hazards Control:
 - 1. Conduct cleaning and disposal operation in accord with legal requirements.

2. Do not burn or bury rubbish and waste materials on Project Site.
3. Do not dispose of volatile wastes in storm or sanitary drains.
4. Store volatile wastes in covered metal containers, and remove from premises daily.
5. Prevent accumulation of wastes which create hazardous conditions.
6. Provide adequate ventilation during use of volatile or noxious substances. Ventilation shall be other than ventilation system.

D. Materials:

1. Use only cleaning materials recommended by manufacturer of surface to be cleaned.
2. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.

E. During Construction:

1. Execute cleaning daily to ensure Project Site, Owner's premises, adjacent and public properties are maintained free from accumulations of waste materials and rubbish.
2. Wet down dry materials and rubbish to control dust.
3. At reasonable intervals during progress of Work, clean Project Site and public properties, and dispose of waste materials, debris and rubbish.
4. Provide on Project Site dump containers for collection of waste materials, debris and rubbish. Waste containers shall not be used for construction waste.
5. Remove waste materials, debris and rubbish from Owner's premises and legally dispose of off Owner's property.
6. Handle materials in a controlled manner with as few handlings as possible. Do not drop or throw materials.

3.5 PROTECTING INSTALLED CONSTRUCTION

- A. Protect installed Work and provide special protection where specified in individual Specification Sections.
- B. Provide temporary and removable protection for installed products. Control activity in immediate Work area to prevent damage.
- C. Prohibit traffic from landscaped areas.

END OF SECTION 01 70 00

SECTION 01 71 13 – MOBILIZATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes but not limited to:
1. mobilization and demobilization;
 2. preparatory work and activities those necessary for the movement of personnel, equipment, supplies, and incidentals to the job site;
 3. for the establishment of all offices, building, trailers, and other facilities necessary for work on the project;
 4. submittals, bonding and insurance requirements;
 5. public notifications in English and Spanish;
 6. contacting and notifying the utility companies;
 7. fabricating and installing project identification signs;
 8. private property owner agreement for storage facilities;
 9. and for all other work and activities which must be performed or costs incurred prior to beginning work on the various contract items on the project site.

1.2 REFERENCES

- A. Cal/OSHA – California Division of Occupation Safety and Health
- B. Underground Services Alert (USA)

1.3 SUBMITTALS

- A. [Section 01 33 00 - Submittal Procedures](#): Requirements for submittals.
- B. Measurement and Payment:
1. When mobilization is included as a bid item, measurement will be made as a percentage of the costs incurred according to the list submitted except that not more than 75% of the bid price shall be paid prior to the final estimate for payment being due, said remaining 25% paid upon completion of cleanup and removal and demobilization with final payment.
 2. When the contract does not include a contract pay item for mobilization, full compensation for any necessary mobilization required shall be considered as included in the prices paid for the various contract items of work involved and no additional compensation will be allowed therefore.

3. The contract price paid for mobilization shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all the work involved in mobilization and demobilization including the items listed in Part 1.1 of this Section as specified herein, and no additional compensation shall be made therefor.
4. Mobilization shall be considered as a non-adjustable contract item. Any contract change orders shall be considered as including full compensation for mobilization.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 MOBILIZATION

- A. Mobilization shall consist of preparatory work and activities listed in Part 1.1 above.
- B. The Contractor shall insure that adequate existing sanitation facilities are available or the Contractor shall provide and maintain adequate sanitation facilities. All wastes and refuse from sanitary facilities provided by the Contractor's operations shall be disposed of away from the site in accordance with all laws and regulations pertaining thereto.
- C. Mobilization shall also include demobilization upon completion of work and cleanup of the site.
- D. The contractor shall provide all labor, materials, equipment and incidentals to prepare the site for the timely start and efficient completion of all work. This includes obtaining all necessary licenses and permits, providing required submittals including but not limited to a detailed project schedule.
- E. Mobilization shall also include notifications to all existing utility companies as shown on the Drawings as first order of work.

END OF SECTION 01 71 13

SECTION 01 71 23 – CONSTRUCTION SURVEYING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes but not limited to:
 - 1. Control Line Survey
 - 2. Pothole Survey
 - 3. Survey Monument Referencing
 - 4. Construction Staking
 - 5. Quality Control Survey
 - 6. As-built GPS Survey
- B. All surveying work shall be performed under the responsible charge of a land surveyor licensed in the State of California.

1.2 REFERENCES

- A. Cal/OSHA – California Division of Occupation Safety and Health
- B. Underground Services Alert (USA)

1.3 SUBMITTALS

- A. [Section 01 33 00 - Submittal Procedures](#): Requirements for submittals.
- B. [Section 02 21 13 - Survey Monuments](#).

1.4 MEASUREMENT AND PAYMENT

- A. The contract price paid for Construction Surveying shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all the work involved in control line survey, survey monument referencing, pothole survey, construction staking, quality control survey and as-built GPS Surveys specified herein, and no additional compensation shall be made therefor.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 GENERAL

- A. All work shall be done in accordance with Chapter 12 of the Caltrans Surveys Manual, Division 00 – General Conditions, Section 7.17, the Special Conditions, the Contract Plans, and as directed by the Engineer.
- B. Contractor shall provide all the project construction surveying and all costs related to establishing a control line, pothole surveying, construction staking, documenting all changes to plans, providing quality control surveying, performing an as-built survey and submitting AutoCAD files of the as-built information. All construction surveying shall be performed under the direction of a Professional Land Surveyor licensed in the State of California. The Contractor shall be responsible for all land surveying and shall be responsible for replacing control points or survey monuments lost or damaged during the course of construction

3.2 CONTROL LINE SURVEY

- A. Prior to any construction surveying contractor will allow for field surveying and office surveying to check the field control shown on the Drawings, and to set construction control points. This survey will be a stand-alone move-in specifically to verify control points. Work includes: collect CAD files from City, submit signed CAD release forms, go to field and tie-in control points, compare the x,y,z of the field data with the x,y,z on the CAD files, establish additional new field control points for construction, and submit CAD file of the existing and new control analysis to engineer for review. All project construction surveying shall be based on this established control line.

3.3 POTHOLE SURVEY

- A. For Projects requiring pothole survey by a Licensed Land Surveyor, during the potholing excavation and exposure of the existing utility, the Contractor's licensed Land Surveyor shall perform a topographic survey of the existing grade, top of pipe of the existing utilities, location of the utility on the project coordinate system. Contractor shall document the outside diameter of the pipe and the pipe material. Contractor shall submit the pothole survey with the above specified information in an AutoCAD Drawing file to the City engineer. CAD point descriptions to include the type of exposed pipe and diameter (example: "12" water")

3.4 SURVEY MONUMENT REFERENCING

- A. For Survey Monument Referencing, refer to [Section 02 21 13 - Survey Monuments](#).

3.5 CONSTRUCTION STAKING

- A. The Contractor shall submit a AutoCAD files to the engineer three (3) working days prior to any staking operation. AutoCAD files will show the calculated survey points with CAD elevations and CAD descriptions as part of the calculated topographic

shots. Cut sheets in-lieu of this requirement will not be accepted. CAD points must include the elevations in CAD.

- B. Construction staking shall be defined as: "Markings set in the field by a CA Licensed Land Surveyor, prior to construction, with horizontal coordinates and vertical dimensions to the items identified below. All field markings shall be completed under the direction of Land Surveyor licensed by the State of California." The Contractor shall be responsible for replacing established survey points lost or damaged during the course of construction.
- C. The list below includes some but not limited to items to be surveyed/staked.
1. Curb/Curb & Gutter - Top of curb, flow line and lip of gutter at begin of curve, end of curve, every 25' and at all changes in direction.
 2. Flushed concrete curb at begin of curve, end of curve, every 25' and at all changes in direction.
 3. Concrete pavers borders
 4. Concrete paving parking
 5. Concrete paving intersection
 6. Curb ramps (beginning, end, mid-point, back corners)
 7. Truncated dome pavers
 8. Concrete Expansion Joints
 9. Trees
 10. Irrigation Meter and Boxes
 11. Traffic Signal Poles and Boxes
 12. Storm Drainage Inlets and other drainage structures
 13. Trench drains
 14. Curb drains
 15. Storm Drainage Piping Inverts every 25' and at all changes in direction
 16. Storm Drainage Manhole Inverts
 17. Sanitary Sewer Piping Inverts every 25' and at all changes in direction
 18. Sanitary Sewer Manhole Inverts
 19. Sanitary Sewer Cleanout
 20. Sanitary Sewer Laterals
 21. Water Main Piping Inverts every 25' and at all changes in direction
 22. Water Main offsets
 23. Water Valves
 24. Air Release Valves
 25. Blow off
 26. Water Meters
 27. Fire Hydrants
 28. Joint Trench every 25' and at all changes in direction
 29. Utility Vaults
 30. Street light pull boxes
 31. Pedestrian Lighting
 32. Street Lighting
 33. Edges of bands a planter curbs

34. Concrete band
35. Corners of Concrete at AC paving limits
36. Bottom and top of concrete speed table slopes
37. Parking strip ticks (one stake each)
38. Parking meter (one stake each)
39. Handicap parking (8 Stakes)
40. Bench
41. News rack & corral (3 stakes each)
42. Midblock arbor, park road arbor (12 stakes each)
43. Bike rack
44. Trash receptacle
45. Fixed bollard, retractable bollard
46. Downspout storm lateral connection. Staking calculations to be adjusted based on field verified building drain locations exposed during demolition.
47. Other staking requirements as described in the Technical Specifications.

3.6 QUALITY CONTROL SURVEY

- A. These survey verifications shall occur one (1) working days prior to pouring concrete. Submit AutoCAD file of the quality control survey to the Engineer one (1) working days prior to pouring concrete curbs and foundations. AutoCAD survey files will show the topographic survey points with elevations and descriptions. Descriptions and elevations will be on the CAD points and not on a separate cut sheet. Contractor will replace any curbs, street lights and pole foundations not checked prior to pouring concrete.
- B. No concrete shall be poured until each quality control survey item described below has been approved by the Engineer, based on survey CAD file provided by contractor's surveyor. Prior to pouring concrete or proceeding beyond subgrade.
- C. Listed below are the project elements which require quality control survey and CAD submittal reviews prior to concrete pouring.
 1. Curbs and Curb & Gutter: After the curb forms are set, the contractor's licensed land surveyor shall survey the top of curb form every 25' and at key conforms.
 2. Subgrade for Street Paving: Field survey and certify the top of aggregate base design grades every 50 feet along the centerline of each lane or on corners of a 12'x50' grid in a parking lot for projects greater than or equal to 5,000 square feet of asphalt concrete. Submit certification signed by a Licensed Land Surveyor.

3.7 AS-BUILT SURVEY

- A. After the trench excavation and pipe installation, the Contractor's licensed land surveyor shall perform a topographic survey of the top of pipes for the utility lines and invert of pipe for all gravity pipes every 25', and at all changes in direction both horizontal and vertical, water valves, tees, water services, fire hydrants and at all manhole. This survey verification shall occur 3 days prior to backfilling trench. AutoCAD files will show the calculated survey points with elevations and descriptions.
- B. Contractor shall be responsible for documenting all changes to the plans. The Contractor/Developer shall provide the as-built survey in .dwg file (tied to NAD83 California State Planes, Zone III) format in AutoCAD 2017 or later version electronically and stored in a USB flash drive. The Contractor/Developer shall deliver one full set (22x34) of hard copy certified by the License Land Surveyor.
- C. A CAD drawing and coordinates data sheet shall be submitted to the Project Manager for approval. This task must be performed by a registered professional land surveyor licensed in the state of California. Data shall be tied to NAD83 California State Planes, Zone III, US Foot. The elevations shall be based on NAVD88 datum. This survey shall be delivered to the City's Engineer of Record. This survey shall be used for final as-built record drawings and calculations of the final quantity.
- D. The topographic survey for the as-built information shall be performed by a Professional Land Surveyor licensed in the State of California. After the trench excavation, pipe installation and approval from the inspector, the Contractor's licensed Land Surveyor shall perform a topographic/As-Built survey of all items described above in Submittals. Surveying will be of the actual pipe, conduit and/or finished facility. As-Built survey shall indicate the actual pipe material installed.

3.8 AS-BUILT GPS SURVEY

- A. Contractor shall be responsible for the GPS "As-Built" Survey, following the completion of construction, for the location and depth of installed underground utility lines, coordinates of manholes, manhole rim elevations, manhole invert elevations, manhole depths, utility boxes, manhole covers and similar appurtenances. A CAD drawing and coordinates data sheet shall be submitted to the project manager for approval. This task must be performed by a registered professional land surveyor licensed in the state of California. Data shall be tied to California State Plan Coordinate System.

END OF SECTION 01 71 23

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SECTION 01 73 29 – CUTTING AND PATCHING

PART 1 - GENERAL

1.1 SUMMARY

- A. General: This section includes requirements for cutting and patching.

1.2 QUALITY ASSURANCE

- A. Installers: Employ skilled and experienced installers to perform cutting and patching.

1.3 SUBMITTALS

- A. Written Request: Submit written request in advance of cutting or altering elements affecting:
 - 1. Structural integrity of element.
 - 2. Integrity of weather-exposed or moisture-resistant elements.
 - 3. Efficiency, maintenance, or safety of element.
 - 4. Visual qualities of sight-exposed elements.
 - 5. Work of Owner or separate contractor.
- B. Request Requirements: Project name and location; description of all affected work; explanation of necessity for cutting, alteration or excavation; impact on the work of the Owner or any separate contractor, or on the structural or weatherproof integrity of the building; description of proposed work, including scope of cutting, patching, alteration, or excavation, products proposed to be used, trades who will complete the work, and extent of refinishing to be done; alternatives to cutting and patching; cost proposal, when applicable; written permission from any separate contractor whose work will be affected.
- C. Product Substitutions: Should conditions of Work or schedule indicate change of products from original installation, submit request for substitution as specified in [Section 01 25 00 - Substitution Procedures](#).
- D. Field Observation: Submit written notice to Project Manager designating date and time work will be uncovered.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. General: Inspect existing conditions; include elements subject to damage or movement during cutting and patching.
- B. After Uncovering Work: Inspect conditions affecting the installation of products, or performance of Work.
- C. Unsatisfactory Conditions: Report unsatisfactory or questionable conditions to the Project Manager in writing; do not proceed with work until Project Manager has provided further instructions.

3.2 PREPARATION

- A. Temporary Support: Provide as necessary to assure structural value or integrity of affected portion of Work.
- B. Protection:
 - 1. Provide devices and methods to protect other portions of the Project from damage.
 - 2. Provide protection from elements for that portion of the Project which may be exposed by cutting and patching, and maintain excavations free from water.

3.3 PERFORMANCE

- A. Cutting and Patching: Execute cutting, fitting, and patching, including excavation and fill if required, to complete Work and to:
 - 1. Fit the several parts together, to integrate with other Work.
 - 2. Uncover Work to install or correct ill-timed Work.
 - 3. Remove and replace defective and nonconforming Work.
 - 4. Remove samples of installed Work for testing.
 - 5. Provide openings in elements of Work for penetrations of mechanical and electrical Work.
- B. Methods: Execute Work by methods to avoid damage to other Work and to provide proper surfaces to receive patching and finishing. Cut masonry and concrete materials using masonry saw or core drill.
- C. Restoration: Restore Work with new products according to requirements of Contract Documents. In the case of failure to protect existing or new work, Contractor shall be responsible for costs to repair damage and for restoring the work.

- D. Penetrations: Fit Work tight to pipes, sleeves, ducts, conduits, and other penetrations through surfaces. Maintain integrity of wall, ceiling, or floor construction; completely seal voids.
- E. Refinishing: Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for assembly, refinish entire unit.
- F. Hazardous Conditions: Identify hazardous substances or conditions exposed during the Work to Project Manager for decision or remedy.

END OF SECTION 01 73 29

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SECTION 01 74 19 – CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL**PART 1 - GENERAL**

1.1 SUMMARY

- A. Description: Provide Construction Waste Management including salvaging, recycling, and disposing of nonhazardous construction waste, as shown and specified per Contract Documents.

PART 2 - PRODUCTS

2.1 WASTE MANAGEMENT PLAN

- A. General: Develop plan, consisting of waste identification and construction methods employed to reduce the amount of waste generated, including separate sections for demolition and construction waste, to re-use and recycle minimum 75% of construction waste materials generated by the Work. Indicate quantities by weight or volume; use same units of measure throughout waste management plan.
- B. Quality Requirements: Refer to [Section 01 42 00 - References](#) for reference standards, applicable codes and definitions, and to the following:
1. American National Standards Institute (ANSI): ANSI 10.2 - Safety Code for Building Construction.
 2. American Society for Testing and Materials (ASTM): Materials and testing standards as identified throughout this Section or within referenced manufacturers' standard specifications.
 3. California Building Code (CBC): California Green Building Standards Code (CALGreen), latest edition: Title 24, Part 11.
 4. California Department of Resources Recycling and Recovery (CalRecycle):
 - a. General: Sustainable Building Guidelines.
 - b. Recycling and Recovery: Construction and Demolition Debris Recycling guidelines.
 5. California Occupational Safety and Health Administration (CalOSHA): Construction Safety Orders; 29 CFR, PART 1926 Safety and Health Regulations for Construction.
 6. Construction & Demolition Recycling Association (CDRA): Standards and guidelines.
 7. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.

PART 3 - EXECUTION**3.1 PREPARATION**

- A. General: Review Waste Management Plan procedures and identify locations established for salvage, recycling, and disposal. Designate and label specific areas on the site for separating materials to be salvaged, recycled, reused, donated, and sold.

3.2 IMPLEMENTATION

- A. City of Pittsburg Construction & Demolition (C&D) Recycling and Waste Management requires at least 65% job-site waste materials diverted from the landfill.
- B. For newly constructed buildings, demolition projects and all locally permitted additions and alterations to non-residential buildings or structures, Contractor shall submit the C&D Debris Waste Management Plan (WMP) showing diverting from landfills at least 65% of the construction materials generated by the project.
- C. Contractor may deliver all approved recycling materials such as wood, metal, plastics, concrete, roofing, cardboard, dirt, sheetrock, tires, appliances, mattresses, box springs, propane tanks, and electronic waste to Contra Costa Waste Service also known as Recycling Center & Transfer Station (RCTS), located at 1300 Loveridge Road, Pittsburg, California. All materials shall be weighed at the RCTS. For any material code of "CD" (Construction & Demolition Material Processing), 100% diversion rate will be applied to receipts indicating the material code "CW" (Clean Wood), "CG" (Clean Green), or "CR" (Clean Roofing).
- D. Recycled Materials: Separate recyclable waste from other waste materials, trash, and debris. Provide properly marked containers or bins for controlling recyclable waste until they are removed from Project site. Store materials away from construction area, off the ground and protect from the weather; do not store within drip line of remaining trees. Transport recyclable waste off Owner's property to recycling receiver or processor.
- E. Disposal: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction. Except as otherwise specified, do not allow waste materials that are to be disposed of to accumulate on-site. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas. Burning and burying of materials is not allowed.
- F. Contractor shall submit the following WMP and Water Assessment table forms.



CITY OF PITTSBURG
65 Civic Avenue
Pittsburg, CA 94565

**CONSTRUCTION AND DEMOLITION DEBRIS
WASTE MANAGEMENT PLAN (WMP)**

For City Use Only	
Project No.	_____
Date	_____ Fee \$ _____
Deposit Amount \$	_____
<input type="checkbox"/>	Approved WMP
<input type="checkbox"/>	Approved Infeasibility Exemption
<input type="checkbox"/>	Denied _____
<input type="checkbox"/>	Further information required _____
Staff Initials	_____

The City of Pittsburg C&D Recycling and Waste Management requirement states that at least 75% diversion of job-site waste materials from the landfill. In order to process the application request, the following form must be completed, signed and submitted with an application fee.

- WMP Application Approval Request WMP Infeasibility Exemption Request

Property Owner Name/Ph.# _____
 Job-site Address: _____
 Contractor/Project Manager: _____
 Address: _____
 Phone Number: _____
 Cellular Phone Number: _____
 Fax Number: _____

Property Owner's Signature / Date

Contractor/Project Manager's Signature / Date

1. Briefly state how materials will be sorted for recycling and/or salvage on the job site. See *Waste Assessment Table on back page*. Attach additional pages if necessary. *If no materials are targeted for recycling or salvage, please state why.

2. Will this project require the use of sub-contractors? Yes No If yes, briefly state how you plan to inform and ensure participation by the sub-contractors of your job-site recycling and waste management responsibility.

Complete Other Side →

WASTE ASSESSMENT TABLE

- I. BEFORE START OF PROJECT: Identify the type of materials to be recycled, salvaged or disposed from the job-site in **Section I** of the Waste Assessment table. Identify the handling procedure, hauler and/or destination of each material type.
- II. UPON COMPLETION OF PROJECT: **Section II** is to be filled out with supporting documentation upon completion of project. Indicate the material **types and quantities** recycled, salvaged or disposed from this job-site. Official weight tags must be submitted with this completed report identifying 1) job site address, 2) weight of load(s), 3) material type(s) and 4) if materials were recycled, salvaged or disposed.

Material Type ↓	Section I Identify materials (✓)			Handling procedure, hauler or final destination of materials* (See #1)	Section II Quantity of each material (lbs)			City Use Only Acceptable weight tag(s) (staff initials)
	Recycle	Salvage	Landfill		Recycled	Salvaged	Landfilled	
Asphalt & Concrete								
Brick, Tile								
Building materials-doors, windows, fixtures, cabinets								
Cardboard								
Dirt/Clean Fill								
Drywall								
Carpet padding/ Foam								
Plate/window Glass								
Scrap Metals (steel, aluminum, brass, copper, etc.)								
Unpainted Wood & Pallets								
Yard Trimmings (brush, trees, stumps, etc.)								
Other:								
Garbage								
TOTALS								% Recycled

FOR CITY USE ONLY – PROJECT COMPLETION (version 11-08)

Full Compliance
 Good Faith Effort to Comply
 Non-Compliance
 Return of Deposit
 Yes
 No
 Amount \$ _____
 Staff Signature _____ / _____
 Date _____

END OF SECTION 01 74 19

SECTION 01 77 00 – CLOSEOUT REQUIREMENTS**PART 1 - GENERAL****1.1 SUMMARY**

- A. This section describes contract closeout procedures including:
 1. Removal of temporary construction facilities
 2. Substantial completion
 3. Final completion
 4. Final cleaning
 5. Miscellaneous Project Record Submittals
 6. Release of claims

1.2 REMOVAL OF TEMPORARY CONSTRUCTION FACILITIES

- A. Remove temporary materials, equipment, services, and construction prior to Substantial Completion Inspection.
- B. Clean and repair damage caused by installation or use of temporary facilities.
- C. Restore permanent facilities used during construction to specified condition.

1.3 SUBSTANTIAL COMPLETION

- A. Preliminary Procedures: Before requesting inspection for certification of Substantial Completion, complete the following. List exceptions in the request.
 1. In the Application for Payment that coincides with, or first follows, the date Substantial Completion is claimed, show 100 percent completion for the portion of the Work claimed as substantially complete.
 2. Include supporting documentation for completion as indicated in these Contract Documents and a statement showing an accounting of changes to the Contract Sum.
 3. If 100 percent completion cannot be shown, include a list of incomplete items, the value of incomplete construction, and reasons the Work is not complete.
- B. Advise the Project Manager of pending insurance changeover requirements.
- C. Submit warranty bonds, final certifications, and similar documents.
- D. Obtain and submit releases enabling the Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.

- E. Submit record drawings in PDF or hard copies in addition to CAD files, maintenance manuals, final project photographs, damage or settlement surveys, property surveys, and similar final record information.
- F. Deliver tools, spare parts, extra stock, and similar items.
- G. Make final changeover of permanent locks and transmit keys to the Owner. Advise the Owner's personnel of changeover in security provisions.
- H. Complete startup testing of systems and instruction of the Owner's operation and maintenance personnel. Discontinue and remove temporary facilities from the site, along with mockups, construction tools, and similar elements.
- I. Complete final cleanup requirements, including touchup painting.
- J. Touch up and otherwise repair and restore marred, exposed finishes.
- K. Inspection Procedures: On receipt of a request for inspection, the Project Manager will either proceed with inspection or advise the Contractor of unfilled requirements. The Project Manager will prepare the Certificate of Substantial Completion following inspection or advise the Contractor of construction that must be completed or corrected before the certificate will be issued.
- L. The Project Manager will repeat inspection when requested and assured that the Work is substantially complete.
- M. Results of the completed inspection will form the basis of requirements for final acceptance.

1.4 FINAL COMPLETION

- A. Preliminary Procedures: Before requesting final inspection for certification of final acceptance and final payment, complete the following. List exceptions in the request.
- B. Submit the final payment request with releases and supporting documentation not previously submitted and accepted. Include insurance certificates for products and completed operations where required.
- C. Submit an updated final statement, accounting for final additional changes to the Contract Sum.
- D. Submit a certified copy of the Project Manager's final inspection list of items to be completed or corrected, endorsed and dated by the Project Manager. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance and shall be endorsed and dated by the Project Manager.

- E. Submit final meter readings for utilities, a measured record of stored fuel, and similar data as of the date of Substantial Completion or when the Owner took possession of and assumed responsibility for corresponding elements of the Work.
 - F. Submit consent of surety to final payment.
 - G. Submit a final liquidated damages settlement statement.
 - H. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 - I. Re-inspection Procedure: The Project Manager will re-inspect the Work upon receipt of notice that the Work, including inspection list items from earlier inspections, has been completed, except for items whose completion is delayed under circumstances acceptable to the Project Manager.
 - 1. Upon completion of re-inspection, the Project Manager will prepare a certificate of final acceptance. If the Work is incomplete, the Project Manager will advise the Contractor of Work that is incomplete or of obligations that have not been fulfilled but are required for final acceptance.
 - 2. If necessary, re-inspection will be repeated.
 - J. Maintenance Manuals: Organize operation and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual, heavy-duty, 2-inch 3-ring, vinyl-covered binders, with pocket folders for folded sheet information. Provide two (2) paper copies and a PDF. Mark appropriate identification on front and spine of each binder. Include the following types of information:
 - 1. Emergency instructions.
 - 2. Spare parts list.
 - 3. Copies of warranties.
 - 4. Wiring diagrams.
 - 5. Recommended "turn-around" cycles.
 - 6. Inspection procedures.
 - 7. Shop Drawings and Product Data.
 - 8. Fixture lamping schedule.
- 1.5 FINAL CLEANING
- A. Execute final cleaning prior to final inspection.
 - B. Clean interior and exterior surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.
 - C. Clean equipment and fixtures to a sanitary condition, clean or replace filters of mechanical equipment operated during construction, clean ducts, blowers and coils of units operated without filters during construction.

- D. Employ skilled workers for final cleaning.
- E. Clean Site; mechanically sweep paved areas.
- F. Remove waste and surplus materials, rubbish, and construction facilities from Site.

1.6 MISCELLANEOUS PROJECT RECORD SUBMITTALS

- A. Refer to Technical Specifications or other Specification Sections for miscellaneous record keeping requirements and submittals in connection with various construction activities. Immediately prior to Substantial Completion, complete miscellaneous records and place in good order, properly identified and bound or filed, ready for use and reference. Submit to the Project Manager for City's records.

1.7 RELEASE OF CLAIMS

- A. Contract will not be closed out and final payment will not be made, subject to provisions of Section 7100 Public Contract Code until all pertinent aspects of [Division 00 - General Conditions](#) regarding undisputed/settled amounts are completed per requirements elsewhere in the Technical Specifications and/or Specifications and executed by Contractor and City.
- B. Contractor shall submit the following Agreement and Release of Any and All Claims Form.

END OF SECTION 01 77 00

SECTION 01 78 00 – CLOSEOUT SUBMITTALS**PART 1 - GENERAL**

1.1 SUMMARY

- A. This section describes contract closeout submittals including:
1. Project record documents
 2. Project guarantee
 3. Warranties

1.2 PROJECT RECORD DOCUMENTS

- A. Project Record Documents required include:
1. Marked-up copies of Contract Drawings
 2. Marked-up copies of Shop Drawings
 3. Project Record Drawings
 4. Marked-up copies of Technical Specifications, Specifications, Addenda and Change Orders
 5. Marked-up Project Data submittals
 6. Record Samples
 7. Field records for variable and concealed conditions
 8. Record information on Work that is recorded only schematically
 9. GPS As-built Survey
 10. Warranty Bonds
- B. Specific Project Record Documents requirements that expand requirements of this Section are included in the individual Sections of Divisions 2 through 48 (when provided).
- C. General Project closeout requirements are included in [Section 01 77 00 - Closeout Requirements](#).
- D. Maintenance of Documents and Samples:
1. Store Project Record Documents and samples in the field office apart from Contract Documents used for construction.
 2. Do not permit Project Record Documents to be used for construction purposes.
 3. Maintain Project Record Documents in good order, and in a clean, dry, legible condition.
 4. Make documents and samples available at all times for inspection by Architect and Project Manager.

- E. City will provide one set of reproducibles and one set of the construction drawing prints and one project manual for the Contractor's use and copying during construction.
- F. Mark-up Procedure: During the construction period, maintain a set of Contract Drawings and Shop Drawings for Project Record Document purposes.
 - 1. Mark these Drawings to indicate the actual installation where the installation varies appreciably from the installation shown originally. Give particular attention to information on concealed elements which would be difficult to identify or measure and record later. Items required to be marked include but are not limited to:
 - a. Dimensional changes to the Drawings
 - b. Revisions to details shown on the Drawings
 - c. Depths of foundations below the first floor
 - d. Locations and depths of underground utilities
 - e. Revisions to routing of piping and conduits
 - f. Revisions to electrical circuitry
 - g. Actual equipment locations
 - h. Duct size and routing
 - i. Locations of concealed internal utilities
 - j. Changes made by Change Order
 - k. Details not on original Contract Drawings
 - 2. Mark completely and accurately Project Record Drawing prints of Contract Drawings or Shop Drawings, whichever is the most capable of showing actual physical conditions. Where Shop Drawings are marked, show cross-reference on Contract Drawings location.
 - 3. Mark Project Record Drawing sets with red ink; use other colors to distinguish between changes for different categories of the Work at the same location.
 - 4. Mark important additional information which was either shown schematically or omitted from original Drawings.
 - 5. Note construction change directive numbers; alternate numbers; Change Order numbers and similar identification.
 - 6. Responsibility for Mark-up: Where feasible, the individual or entity who obtained Project Record Drawing data, whether the individual or entity is the installer, subcontractor, or similar entity, is required to prepare the mark-up on Project Record Drawings.
 - a. Accurately record information in an understandable and legible drawing technique.
 - b. Record data as soon as possible after it has been obtained. In the case of concealed installations, record and check the mark-up prior to concealment.
- G. Preparation of Transparencies: Prior to inspection for Certification of Substantial Completion, review completed marked-up Project Record Drawings with the Project Manager. When authorized, prepare a full set of correct reproductables of Contract Drawings and Shop Drawings.

1. Incorporate changes and additional information previously marked on print sets. Erase, redraw, and add details and notations where applicable. Identify and date each Drawing; include the printed designation "PROJECT RECORD DRAWINGS" in a prominent location on each Drawing.
 2. Refer instances of uncertainty to the Project Manager for resolution.
 3. Review of Reproducible: Before copying and distributing, submit corrected reproducibles and the original marked-up prints to the Project Manager for review. When acceptable, the Project Manager will initial and date each transparency, indicating acceptance of general scope of changes and additional information recorded, and of the quality of drafting.
 - a. Reproducibles and the original marked-up prints will be returned to the Contractor for organizing into sets, printing, binding, and final submittal.
 4. Copies and Distribution: After completing the preparation of reproducible Project Record Drawings, print one hard copy and a PDF of each Drawing, whether or not changes and additional information were recorded. Organize the copies into manageable sets. Bind each set with durable paper cover sheets, with appropriate identification, including titles, dates and other information on cover sheets.
 - a. Organize and bind original marked-up set of prints that were maintained during the construction period in the same manner.
 - b. Organize Project Record Drawings reproducibles into sets matching the print sets. Place these sets in durable tube-type drawing containers with end caps.
- H. Distribution of Marked-Up Drawings and Transparencies: Submit the marked-up Project Record Drawings sets, reproducibles, and one copy to the Project Manager for City's records.
- I. Project Record Technical Specifications and Specifications:
1. During the construction period, maintain one copy of the Project Manual, including addenda and modifications issued, for Project Record Document purposes.
 2. Mark the Project Record Manual to indicate the actual installation where the installation varies substantially from that indicated in Specifications and Modifications issued. Note related Project Record Drawing information, where applicable. Give particular attention to substitutions, selection of product options, and information on concealed installation that would be difficult to identify or measure and record later.
 - a. In each Technical Specifications and Specification Section where products, materials or units of equipment are specified or scheduled, mark the copy with the proprietary name and model number of the product furnished.
 - b. Record the name of the manufacturer, supplier and installer, and other information necessary to provide a record of selections made and to document coordination with Project Record Product Data submittals and maintenance manuals.

- c. Note related Project Record Product Data, where applicable, for each principal product specified, indicate whether Project Record Product Data has been submitted in maintenance manual instead of submitted as Project Record Product Data.
 3. Upon completion of mark-up, submit Project Record Manual to the Project Manager for City's records.
- J. Project Record Product Data:
 1. During the construction period, maintain one copy of each Project Record Product Data submittal for Project Record Document purposes.
 - a. Mark Project Record Product Data to indicate the actual product installation where the installation varies substantially from that indicated in Project Record Product Data submitted. Include significant changes in the product delivered to the site, and changes in manufacturer's instructions and recommendations for installation.
 - b. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 - c. Note related Change Orders and mark-ups of Project Record Drawings, where applicable.
 - d. Upon completion of mark-up, submit a complete set of Project Record Product Data to the Project Manager for City's records.
 - e. Where Project Record Product Data is required as part of maintenance manuals, submit marked-up Project Record Product Data as an insert in the manual, instead of submittal as Project Record Product Data.
- K. Material, Equipment and Finish Data:
 1. Provide data for primary materials, equipment and finishes as required under each Technical Specifications/Specification section.
 2. Submit one set prior to final inspection, bound in 8-1/2 inches by 11 inches three-ring binders with durable plastic covers and a PDF; provide typewritten table of contents for each volume.
 3. Arrange by Technical Specifications/Specification division and give names, addresses, and telephone numbers of subcontractors and suppliers. List:
 - a. Trade names.
 - b. Model or type numbers.
 - c. Assembly diagrams.
 - d. Operating instructions.
 - e. Cleaning instructions.
 - f. Maintenance instructions.
 - g. Recommended spare parts.
 - h. Product data.
- L. Miscellaneous Project Record Submittals:
 1. Refer to other Technical Specifications/Specification Sections for miscellaneous record keeping requirements and submittals in connection with various construction activities. Immediately prior to Substantial

Completion, complete miscellaneous records and place in good order, properly identified and bound or filed, ready for use and reference. Submit to the Project Manager for City's records. Field records documenting elevations and locations of completed improvements shall require Contractor-retained State of California Licensed surveyor's certification stamp. Categories of requirements resulting in miscellaneous records include, but are not limited to the following:

- a. Field records on excavations and foundations
 - b. Field records on underground construction and similar work
 - c. Survey showing locations and elevations of underground lines
 - d. Invert elevations of drainage piping
 - e. Surveys establishing building lines and levels
 - f. Authorized measurements utilizing unit prices or allowances
 - g. Records of plant treatment
 - h. Ambient and substrate condition tests
 - i. Certifications received in lieu of labels on bulk products
 - j. Batch mixing and bulk delivery records
 - k. Testing and qualification of tradespersons
 - l. Documented qualification of installation firms
 - m. Load and performance testing
 - n. Inspections and certifications by governing authorities
 - o. Leakage and water-penetration tests
 - p. Fire resistance and flame spread test results
 - q. Final inspection and correction procedures
- M. GPS As-built Survey: Refer to [Section 01 71 23 - Construction Surveying](#) for As-Built GPS Survey.
- N. Periodic Review:
1. Make additions to the Project Record Documents as they occur.
 2. Make the Project Record Documents available to the Project Manager for periodic review. The Project Manager's review of the current status of Project Record Documents is a requisite to approval of requests for progress payment.
 3. Prior to submitting each request for progress payment, secure the Project manager's approval of the current status of the Project Record Documents.
 4. Prior to submitting request for final Payment, submit the final Project Record Documents to the Project Manager for approval.
- O. Submittal: At the completion of Project, deliver record documents to Project Manager.
- 1.3 PROJECT GUARANTEE
- A. Requirements for Contractor's guarantee of completed Work are included in [Division 00 - General Conditions](#). Contractor shall guarantee Work done under Contract against failures, leaks or breaks or other unsatisfactory conditions due to

defective equipment, materials or workmanship, and perform repair work or replacement required, at Contractor's sole expense, for period of one year, unless otherwise subject to any special warranty periods of longer duration, from date of Final Acceptance.

- B. Neither recordation of final acceptance nor final certificate for payment nor provision of the Contract nor partial or entire use or occupancy of premises by City shall constitute acceptance of Work not done in accordance with Contract Documents nor relieve Contractor of liability in respect to express warranties or responsibility for faulty materials or workmanship.
- C. City may make repairs to defective Work as set forth in paragraph 10.C.3 of [Division 00 - General Conditions](#), if, within five (5) working days after mailing of written notice of defective work to Contractor or authorized agent, Contractor shall neglect to make or undertake repair with due diligence; provided, however, that in case of leak or emergency where, in opinion of City, delay would cause hazard to health or serious loss or damage, repairs may be made without notice being sent to Contractor, and Contractor shall pay cost thereof.
- D. If, after installation, operation or use of materials or equipment to be furnished under Contract proves to be unsatisfactory to Project Manager, City shall have right to operate and use materials or equipment until it can, without damage to City, be taken out of service for correction or replacement. Period of use of defective materials or equipment pending correction or replacement shall in no way decrease guarantee period required for acceptable corrected or replaced items of materials or equipment.
- E. Nothing in this Section shall be construed to limit, relieve or release Contractor's, subcontractors' and equipment suppliers' liability to City for damages sustained as result of latent defects in equipment caused by negligence of suppliers' agents, employees or subcontractors. Stated in another manner, warranty contained in the Contract Documents shall not amount to, nor shall it be deemed to be, waiver by City of any rights or remedies (or time limits in which to enforce such rights or remedies) it may have for defective workmanship or defective materials under laws of this State pertaining to acts of negligence.

1.4 WARRANTIES

- A. Execute Contractor's submittals and assemble warranty documents executed or supplied by subcontractors, suppliers, and manufacturers.
 - 1. Provide table of contents and assemble in 8-1/2 inches by 11 inches three-ring binder with durable plastic cover.
 - 2. Assemble in Technical Specifications/Specification Section order.
 - 3. Submit material prior to final application for payment.
 - 4. For equipment put into use with City's permission during construction, submit within ten (10) working days after first operation.

5. For items of Work delayed materially beyond Date of Substantial Completion, provide updated submittal within ten (10) working days after acceptance, listing date of acceptance as start of warranty period.
 6. Warranties are intended to protect City against failure of work and against deficient, defective and faulty materials and workmanship, regardless of sources.
 7. Limitations: Warranties are not intended to cover failures which result from the following:
 - a. Unusual or abnormal phenomena of the elements
 - b. Vandalism after substantial completion
 - c. Insurrection or acts of aggression including war.
- B. Related Damages and Losses: Remove and replace Work which is damaged as result of defective Work, or which must be removed and replaced to provide access for correction of warranted Work.
- C. Warranty Reinstatement: After correction of warranted Work, reinstate warranty for corrected Work to date of original warranty expiration or to a date not less than ninety (90) days after corrected Work was done, whichever is later.
- D. Replacement Cost: Replace or restore failing warranted items without regard to anticipated useful service lives.
- E. Warranty Forms: Submit drafts to Project Manager for approval prior to execution. Forms shall not detract from or confuse requirements or interpretations of Contract Documents.
- F. Warranty shall be countersigned by manufacturers.
- G. Where specified, warranty shall be countersigned by subcontractors and installers.
- H. Rejection of Warranties: City reserves right to reject unsolicited and coincidental product warranties which detract from or confuse requirements or interpretations of Contract Documents.
- I. Term of Warranties: For materials, equipment, systems and workmanship warranty period shall be one-year minimum from date of final completion of entire Work except where:
 1. Detailed specifications for certain materials, equipment or systems require longer warranty periods.
 2. Materials, equipment or systems are put into beneficial use of City prior to Final Completion as agreed to in writing by Project Manager.
- J. Warranty of Title: No material, supplies, or equipment for Work under Contract shall be purchased subject to any chattel mortgage, security agreement, or under a conditional sale or other agreement by which an interest therein or any part thereof is retained by seller or supplier. Contractor warrants good title to all material, supplies, and equipment installed or incorporated in Work and agrees

upon completion of all work to deliver premises, together with improvements and appurtenances constructed or placed thereon by Contractor, to City free from any claim, liens, security interest, or charges, and further agrees that neither Contractor nor any person, firm, or corporation furnishing any materials or labor for any Work covered by Contract shall have right to lien upon premises or improvement or appurtenances thereon. Nothing contained in this Paragraph, however, shall defeat or impair right of persons furnishing materials or labor under bond given by Contractor for their protection or any rights under law permitting persons to look to funds due Contractor in hands of City.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION 01 78 00

SECTION 01 78 23
OPERATION AND MAINTENANCE INFORMATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Providing Operation and Maintenance (O&M) information for each maintainable piece of equipment, equipment assembly or subassembly, and material provided or modified under this Contract.
 - 1. Provide in the form of an instructional manual for use by Owner's personnel.
 - 2. Provide a separate manual for each piece of equipment (i.e., submersible pumps will have a separate manual from vertical turbine pumps). One exception is that O&M Manuals for valves specified in Division 15 may be combined into one manual.
 - 3. O&M Manuals are required for equipment, specialties, electrical, and instruments included in, but not limited to, the following sections:

Section	Title
XX XX XX	Title
XX XX XX	Title

1.2 REFERENCED SECTIONS

- A. The following Sections are referenced in this Section
 - 1. Section 01 33 00 – Submittals
 - 2. Section 01820 – Training
 - 3. Section 01 99 00 – Reference Forms

1.3 SUBMITTALS

- A. Submit in accordance with Section 01 33 00.
- B. Submit preliminary O&M manuals in electronic format.
 - 1. Refer to "Format Requirements – Electronic Copies" below.
 - 2. Include all material in final O&M manual except startup and field testing information.
 - 3. Engineer and Owner will review manuals. Make additions and revisions in accordance with review comments.
- C. Submit final O&M manuals in hard-copy and in electronic format on CD or DVD.
 - 1. Include startup and field testing information.
 - 2. Submit two (2) final hard copy O&M Manuals and one (1) electronic copy on CD or DVD for review. Hard copies will be returned to Contractor.
 - 3. Provide five (5) approved O&M manuals and two (2) copies on CD or DVD to Owner.
- D. O&M Manuals must be submitted and accepted before on-site training, specified in Section 01820, may start.

- E. Submittals that are not fully indexed and tabbed with sequentially numbered pages may be returned without review.
- F. Complete and submit O&M Information Transmittal (See Section 01 99 00) with each Manual.
- G. Deferred submittal parts, which need not be included with final manuals, but shall be included with approved manuals:
 - 1. Master Volume Index as specified in Paragraph 2.01
 - 2. Include test reports as specified in Paragraph 2.05 in final O&M manuals.
 - 3. Include forms required during startup and training in final O&M manuals.
 - 4. Include completed Equipment Record Forms with equipment serial numbers, as specified in Paragraph 2.02, in final O&M manuals.
- H. Submit data for import in a Computerized Maintenance Management System (CMMS) as specified under Paragraph 2.07 below.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Each O&M Manual shall provide instructions and procedures for all aspects of equipment installation, operation, and maintenance including: delivery, handling, storage, maintenance during storage, assembly, erection, installation, startup, adjusting, testing, operating, shutdown, troubleshooting, maintenance, and as may otherwise be required.
- B. Organize information in a consistent format under separate headings for each different procedure, with a logical sequence of instructions for each procedure.
- C. Where manufacturers' standard pre-printed manuals are included in O&M Manuals, mark to reflect only the model or series of equipment used on the Project. Neatly cross out non-applicable material.
- D. Master Volume Index
 - 1. Provide a neatly typewritten master index of all O&M manuals.
 - 2. List each manual as Volume ___ of ___.
 - 3. Include a copy of the index at the front of each manual. Clearly call out the manual in the index.

2.2 FORMAT REQUIREMENTS – GENERAL

- A. Cover: Provide a cover page the includes the following information:
 - 1. "OPERATION AND MAINTENANCE MANUAL, VOLUME NO. ___ OF ___"
 - 2. Project Name
 - 3. Owner Project Number
 - 4. Specification Number(s)
 - 5. Equipment Name(s)
 - 6. Equipment Tag Numbers
- B. Title Page: Provide a title page at the front of each Equipment O&M Manual containing the following information:
 - 1. Owner Name and Project Name

2. Equipment Name
 3. Specification Section
 4. Equipment Tag Numbers
 5. Equipment Model Numbers
 6. Equipment Serial Numbers
 7. Names, addresses, telephone numbers and individuals to contact for the manufacturer, the nearest representative of the manufacturer, and the nearest supplier of the manufacturer's equipment and parts
 8. Engineer name, address, and telephone number
 9. Contractor, name of responsible principal, address, and telephone number.
 10. Date
- C. Table of Contents
1. Number each page of O&M Manuals and provide a typed table of contents with page numbers at the front of each O&M Manual.
 2. Divide the O&M Manuals into major sections and subsections, to allow easy location of material. At a minimum, list each major section in the table of contents.
 3. Provide a fly sheet for each major section listed in the table of contents, with section title printed on fly sheet.
- D. Section 1: Reserve Section 1 of the manual for the following:
1. Equipment Record Forms (Section 01 99 00 and Division 26)
 - a. Fill out by machine. Hand entries will not be allowed.
 - b. Include all required information. The Equipment Record Form is intended as an easily accessible quick reference for plant operation and maintenance personnel.
 - c. Equipment record sheet for electrical/instrumentation equipment shall be as specified in Division 16. Include a complete list of items supplied, including serial numbers, ranges, options, and other pertinent data necessary for ordering replacement parts.
 2. Startup forms required by individual specification sections. These may include but are not limited to the following forms in Section 01 99 00:
 - a. Equipment Test Report
 - b. Manufacturer's Representative Service Report
 - c. Manufacturer's Installation Certification Form
 - d. Manufacturer's Instruction Certification Form
- E. Presentation of Data
1. Include only those sheets that are pertinent to the specific product.
 2. Annotate each sheet to:
 - a. Clearly identify the specific project or part installed.
 - b. Clearly identify the data applicable to the installation.
 - c. Cross-out references to inapplicable information.
 3. Identify each product by product name and other identifying numbers or symbols as set forth in Contract Documents.

4. Material shall be suitable for reproduction, with quality equal to original. No scanned or faxed copies of standard published manuals and product data available from manufacturers will be allowed.

F. Text

1. Manufacturer's printed data properly edited for project. Cross out all data that does not apply to the equipment to be furnished. Clearly annotate to identify applicable product, part, or data.
2. All documents shall be machine typed; hand written documents are not acceptable. All documents shall be legible and original size, documents that cannot be read or have been reduced will be returned for correction.

2.3 FORMAT REQUIREMENTS – HARD COPIES

A. Binders

1. Bind Equipment O&M Manuals in heavy duty hard cover three-ring "Slant D" binders with clear vinyl overlay pocket on binder front and spine, Avery Dennison, Heavy Duty, EZD, View Binder or equal.
2. Insert cover page specified above into clear pocket on front of each binder.
3. Provide with heavy plastic-coated section dividers with numbered plastic index tabs.
4. Include plastic sheet lifters prior to first page and following last page.

B. Spine Label

1. Provide a spine label to be inserted into the clear pocket on the spine of each binder. Include the following information on the spine label:
 - a. Equipment Name(s)
 - b. Specification Number(s)
 - c. Equipment Tag Numbers.
 - d. Appendix number and/or volume number

C. Drawings

1. Drawings reduced to 11-inch by 17-inch are acceptable if they are clear and readable, and are neatly and individually double-folded to 8-1/2-inch by 11-inch size. Drawing title shall be visible in lower right hand corner of the original and folded drawing. Reinforce binding edge with clear Mylar strip.
2. Larger drawings or illustrations are acceptable if neatly folded and individually placed in an 8-1/2-inch by 11-inch clear plastic pocket which fits in the binder. Only one drawing or illustration shall be placed in each pocket. Drawing title shall be visible in lower right hand corner of the original and folded drawing.

D. Additional formatting requirements:

1. Paper Size: 8-1/2 inches by 11 inches, except as noted below.
2. Paper: 20-pound minimum, white for typed pages.
3. Arrange printing so that punched holes do not obliterate data and use hole reinforcements for bound in plan sheets.

2.4 FORMAT REQUIREMENTS - ELECTRONIC COPIES

- A. Include all information in the hard-copy Operation and Maintenance Manuals.
- B. Insert fly sheets as specified above at the location of tabbed section dividers.

- C. Provide as a single, searchable PDF file. Generate PDF files from original documents to enable text searches.
- D. The files shall become the property of the Owner for use in training programs and other uses.

2.5 CONTENTS OF MANUALS

A. Product Data

- 1. Provide manufacturer's catalog data indicating equipment and accessories provided for the Project. Include only those sheets that are pertinent to the products supplied and delete references to inapplicable information.
- 2. Supplement product data with drawings as necessary to clearly illustrate relations of component parts of equipment and systems.
- 3. Provide "As Constructed" submittal shop documents, data sheets, and drawings, including all items in the electrical/instrumentation system as specified in Division 16. Contract documents shall not be used as "As Constructed" drawings.

B. Drawings

- 1. Supplement product data with drawings as necessary to clearly illustrate:
 - a. Relations of component parts of equipment and systems. Include individual parts list with exploded views for all equipment.
 - b. Control and flow diagrams.
- 2. Coordinate drawings with information in project contract documents to assure correct illustration of completed installation.

C. Equipment Description

- 1. Theory of Operation.
- 2. Description: Provide description of unit and component parts functions, normal operating characteristics, and limiting conditions.
 - a. Include descriptive bulletins, brochures, or catalog sheets to describe the equipment.
 - b. Include performance curves, engineering data, and test results.

D. Procedures

- 1. Safety Procedures: Manufacturer's safety procedures for operating and maintaining all equipment and materials used. List personnel hazards and safety precautions for all operating conditions.
- 2. Shipping and Installation Procedures
 - a. Receiving and handling.
 - b. Short-term storage, long-term storage and maintenance during storage.
 - c. Complete step-by-step installation instructions for all components.
 - d. Startup, adjusting and testing.

E. Operating Instructions

- 1. Provide complete, detailed, written description of the sequence of operations for all operations in all modes. Prepare specifically for this work and reference to control diagrams and system components.
 - a. Recommended step-by-step pre-start, startup, adjustment, calibration, and break-in operating instructions.

- b. Recommended step-by-step regulation and control instructions for routine operation. Include summer and winter operating instructions as applicable. Include any special operating instructions.
 - c. Recommended step-by-step stopping, shut-down, and post-shutdown instructions.
 - 2. Staff Service Requirements: Provide instructions for services to be performed by the staff such as lubrication, adjustments, and inspection.
 - 3. Current and desired control settings.
 - 4. Emergency Procedures.
 - a. Provide emergency procedures for equipment malfunctions to permit a short period of continued operation or to shut down the equipment to prevent further damage to systems and equipment.
 - b. Include emergency shutdown instructions for fire, explosion, spills, or other foreseeable contingencies.
- F. Preventive Maintenance Information
 - 1. Preventive Maintenance Plan and Schedule
 - a. Provide manufacturer's schedule for routine preventive maintenance, inspections, tests, and adjustments required to ensure proper and economical operation and to minimize corrective maintenance and repair.
 - b. Provide manufacturer's projection of preventive maintenance man-hours on a daily, weekly, monthly, and annual basis.
 - 2. Lubrication information
 - a. Lubrication schedule showing service interval frequency
 - b. Table showing recommended lubricants for specific temperature ranges and applications
 - 1) For each required lubricant, provide a list of acceptable equivalents from at least one different major manufacturer whose products are locally available.
 - c. Include a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities
 - 3. Additional requirements
 - a. Include procedures for disassembly, assembly, alignment, adjusting, and checking.
 - b. Provide manufacturer's printed maintenance instructions.
 - c. Include illustrations, assembly drawings, and diagrams required for maintenance.
- G. Corrective Maintenance Information
 - 1. Corrective maintenance to include disassembly, repair, overhaul and re-assembly.
 - 2. Provide manufacturer's step-by-step trouble shooting and diagnostic procedures to promptly isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or require replacement.
 - 3. Provide manufacturer's step-by-step procedures and list required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances,

dimensions, settings, and adjustments required. Instructions shall include a combination of text and illustrations

4. Wiring diagrams and control diagrams shall be point-to-point drawings of wiring and control circuits including factory-field interfaces. Provide a complete and accurate depiction of the actual job-specific wiring and control work. On diagrams, number electrical and electronic wiring and pneumatic control tubing and the terminals for each type identically to actual installation numbering.
5. Provide manufacturer's instructions and list tools required to restore product or equipment to proper condition or operating standards
6. Provide manufacturer's projection of corrective maintenance man-hours including craft requirements by type of craft.

H. Electrical and Instrumentation Information

1. Electrical & Instrumentation Drawings shall include as-built information per Division 16 for the project. As-built drawings shall be signed and stamped by an electrical engineer registered in the State of California.
2. Complete software ladder logic printouts.
3. Record of all settings or parameters for all programmable devices.
4. At the end of the project these manuals shall be updated to show "as-built" or "as-installed" conditions, including any field changes.

I. Parts Identification

1. Provide full identification and listing of all parts of each component, assembly, subassembly, and accessory.
 - a. Identify parts by make, model, serial number, and source of supply to allow reordering without further identification.
 - b. Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate listing shall show the index, reference, or key number which will cross reference the illustrated part to the listed part.
2. Include schematic diagrams of all electronic devices. Provide a complete parts list with stock numbers for the components that make up the assembly.
3. Include special hardware requirements, such as requirement to use high-strength bolts and nuts.
4. Include control and flow diagrams and panel wiring diagrams.
5. Coordinate drawings to ensure correct illustration of completed installation.

J. Spare Parts:

1. Provide lists of spare parts and supplies required for maintenance and repair to ensure continued service or operation without unreasonable delays.
 - a. Manufacturer's recommended spare parts list with manufacturer's current prices.
 - b. Include complete nomenclature and commercial numbers of replaceable parts.
 - c. List spare parts and supplies that have a long lead-time to obtain.
 - d. Provide a table showing the predicted life of parts subject to wear.
2. Include spare parts list on Equipment Record Forms A and B (Section 01 99 00).

- K. Test Data
 - a. Provide copies of factory test reports as specified in the applicable equipment sections.
 - b. After field testing is completed, include field test data.
 - c. Include performance curves and engineering data.
- L. Additional Information
 - 1. Provide any information not specified in the preceding paragraphs but pertinent to the maintenance or operation of the product or equipment. Examples include:
 - a. Information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components.
 - b. Instances that might affect the validity of Warranties or Bonds

2.6 APPENDICES:

- A. Submittals
 - 1. Include a copy of all approved submittals.
- B. Warranty Information
 - 1. List and explain the various warranties and include the servicing and technical precautions prescribed by the manufacturers or contract documents to keep warranties in force.
- C. Personnel Training
 - 1. Provide information available from the manufacturers to use in training designated personnel to operate and maintain the equipment and systems properly.
 - 2. Refer to **Section 01820** for additional training information.

2.7 COMPUTERIZED MAINTENANCE MANAGEMENT SYSTEM

- A. Collate and submit information on the new and modified equipment, specialties, electrical, and instrumentation installed during the Project, for potential import into a Computerized Maintenance Management System (CMMS).
- B. Data Format
 - 1. Submit equipment and instrument information in a database file format suitable for direct import to an SQL-based relational database management system, without additional data manipulation.
 - 2. The acceptable format is Microsoft Excel file format.
 - 3. Format data in row (equipment name or tag) and column (equipment, name, tag, description, and various features as noted herein) so that it can be added to the SCADA database.
- C. Data Content
 - 1. Maintenance information to be provided shall include all equipment information relevant to a reliability-centered maintenance program.
 - 2. File and file name of electronic (PDF version) of equipment manual.
 - 3. The spreadsheet information shall include, but is not limited to, the following:
 - a. General information required for all equipment:
 - 1) Equipment or instrument name, model number, serial number

- 2) Equipment or instrument tag numbers
 - 3) Description
 - 4) Equipment cost
 - 5) Manufacturer and local representative name and contact information
 - 6) Dates of purchase, installation and commissioning
 - 7) List of spare parts, including part number, quantity, name and cost
 - 8) Required inspections and frequency
 - 9) Required preventive maintenance procedures and frequency
- b. Mechanical equipment information:
- 1) Lubrication information, including lubrication points, frequency of lubrication, and recommended lubricants
 - 2) Replaceable wear components and recommended replacement intervals
- c. Electric motor information:
- 1) Frame number
 - 2) Horsepower
 - 3) Amperages
 - 4) Voltage, frequency, number of phases
 - 5) RPM
 - 6) Service factor
 - 7) Duty
 - 8) NEMA design code
 - 9) Insulation class
 - 10) Ambient temperature rating
 - 11) Temperature rise
- d. Instrumentation equipment information:
- 1) Instrument type
 - 2) NEMA rating
 - 3) Size
 - 4) Range
 - 5) Power requirements
 - 6) Output units
 - 7) Output signal (e.g. millivolts, 4-20 milliamps, pulse)
 - 8) Communications protocol (where applicable)

D. Submittal Requirements

1. Submit a complete draft electronic copy of the equipment and instrument information database for City review at least three (3) months prior to the project acceptance.
2. The City will provide comments on the draft database within ten (10) Working Days of receipt. City comments on subsequent drafts of the equipment and instrument information database will be provided within five (5) Working Days of receipt, provided that major revisions requiring additional review time have not occurred.
3. The equipment and instrument information database shall not be considered complete until approved by the City. Approval will not be unreasonably withheld.

4. Following review and approval, the Contractor shall submit one (1) electronic copy of the equipment and instrument information database to the City.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 81 00
EQUIPMENT AND SYSTEM TESTING, STARTUP AND DEMONSTRATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Requirements for Performance Testing, Facility Startup and Operational Testing, and the Demonstration Periods for all the mechanical, electrical, instrumentation, HVAC equipment and systems.
- B. Requirements for the documentation of all testing work.
- C. This section supplements the specific testing requirements found in the individual sections of these Specifications.

1.2 REFERENCED SECTIONS

- A. The following Sections are referenced in this Section
 - 1. Section 01 33 00 – Submittal Procedures
 - 2. Section 01820 – Training
 - 3. Section 01 99 00 – Reference Forms

1.3 OVERVIEW

- A. The general sequence of testing and startup will proceed as follows. Expanded information on each item is presented later in this Section.
 - 1. Submittals
 - a. All relevant submittals, operation and maintenance manuals and factory testing shall be completed and acceptable to the Engineer.
 - 2. Calibration
 - a. All test equipment to be used during the testing shall be calibrated.
 - 3. Testing Preparation
 - a. Preparation for actual testing (visual inspections, lubrication, etc.) shall take place upon completion of calibration.
 - 4. Performance Testing
 - a. Conduct for each piece of equipment to verify its operation prior to putting the entire system on-line.
 - b. Continuous 8-hour period for each piece of equipment is required.
 - 5. Training
 - a. Conduct training of the Owner's personnel after verifying that the individual pieces of equipment are in working order.
 - 6. Facility Startup/Operational Testing
 - a. Facility Startup/Operational Testing shall take place upon completion of training.
 - b. Testing is intended to verify that the facility as a whole is functioning properly.

7. Demonstration Period

- a. The Demonstration Period will be used to demonstrate the longer term functionality of the facility and be a continuous period.

1.4 CONTRACTOR'S TESTING MANAGER

- A. Appoint a qualified professional as the Contractor's Testing Manager to manage, coordinate, and supervise the Testing Program.
- B. Minimum (5) five years' experience in managing the startup and operation of mechanical, electrical, instrumentation, HVAC, and piping systems is required.

1.5 SUBMITTALS

- A. Comply with Section 01 33 00 and include the following information:
1. Designate in writing the appointed Testing Manager, including a resume demonstrating compliance with the requirements of this Section, to the Engineer prior to implementation of the Testing Program.
 2. Credentials and certification of the testing laboratory proposed by the Contractor for calibration of all test equipment.
 3. A schedule for the Performance Testing, Facility Startup/Operational Testing, and Demonstration Period updated monthly (weekly when testing is taking place).
 4. An Equipment Testing Plan to be used during Performance Testing.
 5. A Facility Startup/Operational Testing and Demonstration Plan.
 6. Calibration and Performance Test results, documented as required by the test program, of equipment or system prior to commencement of the Operational Test.
 7. The original and three copies of all records produced during the Testing Program.
 8. Completed Equipment Test Report Form for each piece of equipment. Sample form is located in Section 01 99 00.

PART 2 - PRODUCTS

2.1 EQUIPMENT TESTING PLANS

- A. The objective of the Equipment Testing Plan shall be to demonstrate, to the Engineer's satisfaction, that the structures, systems, and equipment meet performance requirements.
- B. In addition, the Equipment Testing Plan shall produce a record of baseline operating conditions for the Owner.
- C. The Contractor shall participate with the Engineer in the development of the Equipment Testing Plan which will be based on the detailed testing requirements as stated in the individual Specification sections.
1. The Equipment Testing Plan shall be divided into the various process systems.
 2. The Equipment Testing Plan shall include tests and documentation procedures for the calibration of all analysis instruments and control sensors followed by step-by-step procedures for the Performance Testing, Facility Startup/Operational Testing, and Demonstration Testing for each individual item of mechanical, electrical, and instrumentation equipment, and for the facility as a whole as specified in the individual Sections.

3. The Contractor shall be responsible for leading the development of the Equipment Testing Plan effort and the Equipment Testing Plan shall be reviewed and accepted by the Engineer prior to beginning any testing.
- D. Submit Equipment Test Report Forms (sample form located in Section 01 99 00) for each item of equipment to be tested. The sample is furnished as a means of illustrating the level of detail required for preparation of equipment and test report forms for this project. The minimum information to be included shall be as follows:
1. Project Name.
 2. Equipment or item tested (including tag numbers).
 3. Date and time of test.
 4. Type of test performed (Performance or Operational).
 5. Test conditions.
 6. Manufacturer's representatives present during testing (if applicable)
 7. Temporary systems required during the testing (if applicable)
 8. Test results.
 9. Calibration documentation for all test equipment (including test laboratory)
 10. Signature space for Contractor and Engineer.
- E. Provide a bar graph testing schedule using Primavera Schedule, or other format as directed by the Construction Manager, establishing the time period when the Contractor plans to proceed with the testing of the completed systems and each system element.
1. Include a description of the temporary systems and installations planned to allow testing to take place.
 2. Detail the sequence, time and duration of Performance Testing, Facility Startup/Operational Testing, and the Demonstration Period.
 3. No testing or startup shall take place on dates and times other than those given in the testing schedule.

PART 3 - EXECUTION

3.1 CONTRACTOR'S RESPONSIBILITIES

- A. Provide, at no expense to the Owner, all fuel, chemicals, compressed air supplies, all labor, temporary piping, valves, gauges, test equipment, heating, ventilating, air conditioning and all other items and work required to complete the tests.
- B. Maintain temporary facilities until permanent systems are in service.
- C. Arrange for the manufacturer's representatives to revisit the Site as often as necessary to correct malfunctions to the Engineer's satisfaction.

3.2 CONTRACTOR'S TESTING MANAGER

- A. Organize qualified representatives of equipment suppliers, subcontractor's, the Contractor's independent testing laboratory, and others, as appropriate, to calibrate and test the equipment, systems, and the facility as a whole. Testing shall follow the procedures and sequences as described in the Equipment Testing Plan.
- B. Document test results on forms provided in the Equipment Testing Plan, including but not limited to the Equipment Test Report form, as previously described.

- C. Conduct at least weekly meetings with the test team and the Engineer beginning one week prior and continuing during equipment testing periods to discuss procedures and testing results.
- D. Be present during equipment testing, facility startup, and meetings and shall be available at all times during the Demonstration Period.

3.3 TEST EQUIPMENT CALIBRATION

- A. Conduct a calibration program for all instruments, gages, meters, monitors, and thermometers used for determining the performance of equipment and systems to be tested.
- B. Calibrate all test equipment (gages, thermometers, meters, analysis instruments, and other equipment) used for calibrating or verifying the performance of equipment installed under this contract to an accuracy at least as accurate as the tolerance specified for the item being tested with $\pm 2\%$ of actual value at full scale being the maximum allowable.
- C. Select test equipment employed for individual test runs so that expected values as indicated by the detailed performance specifications will fall between 60 and 85% of full scale.
- D. Standards
 - 1. Pressure gages: Calibrate in accordance with ANSI/ASME B40.1.
 - 2. Thermometers: Calibrate in accordance with ASTM E77.
 - 3. Liquid flow meters, including all open channel flow meters and all meters installed in pipelines with diameters greater than 2": Calibrate in situ using either the total count or dye dilution methods.
 - 4. Ultrasonic level and magnetic type flow meters: Calibrate per manufacturers' recommendations.
 - 5. For gas flow meters installed in piping systems with diameters greater than 6": Submit factory calibration curves for the primary element and calibrate the transmitters onsite per factory specifications.

3.4 TESTING PREPARATION

- A. The following steps apply to each process system or facility as it is readied for startup and operation:
 - 1. Submittals
 - a. All submittals relevant to installation practices, equipment, piping, anchorage calculations, instrumentation, materials, and testing plans have been submitted to the Engineer and received "No Exceptions Taken" or "Make Corrections Noted" review status.
 - 2. Factory Testing
 - a. Where required prior to the shipment of equipment to the site, complete factory testing.
 - b. Such testing may be both unwitnessed and witnessed by the Engineer and/or Owner as specified and at their discretion.
 - 3. Operations and Maintenance Manuals
 - a. Operations and maintenance manuals for equipment shall be submitted and receive "No Exceptions Taken" or "Make Corrections Noted" review status.

4. Construction Complete
 - a. Construction is substantially complete so that facility is ready to be used for its intended purposes and all signage is posted.
 - b. All construction deficiencies shall be corrected prior to testing, unless agreed by Owner that testing can begin concurrent with correcting a construction deficiency.
5. Inspection
 - a. Inspect and clean equipment, devices, connected piping, and structures to ensure they are free of foreign material.
6. Lubrication
 - a. Lubricate equipment in accordance with manufacturer's instructions.
7. Regulatory Agency Approvals
 - a. Conduct inspections and tests as required by regulatory agencies (Air Quality Control Board, California Regional Water Quality Control Board, etc.) and as necessary to gain approval to operate the treatment facilities.
 - b. Provide written information as required by regulatory agencies.

3.5 PERFORMANCE TESTING

A. General

1. Test each item and system of mechanical, electrical, instrumentation, and HVAC equipment installed under this contract for 8-hours continuously to demonstrate compliance with the performance requirements of the individual Specification sections, unless otherwise specified.
2. Follow the approved Equipment Testing Plan and detailed procedures specified.
 - a. Unless otherwise indicated, furnish all labor, materials, and supplies for conducting the test and taking all samples and performance measurements.
 - b. Prepare Performance Test reports summarizing test methods and results as described in the Equipment Testing Plan.
3. Performance test all project equipment and systems in all modes of operation including remote PLC modes of operation.
4. Test the utility, chemical feed, safety equipment and other support systems before testing the process system.

B. Pressure and Leakage Tests

1. Conduct pressure and leakage tests in accordance with applicable portions of Divisions 2, 3, 10, 13, and 15 and complete prior to any testing of connected mechanical equipment or valves.
2. All tests shall be witnessed by the Engineer.
3. Evidence of successful completion of the pressure and leakage tests shall be the Engineer's signature on Pipe Test Record Form located in Section 01 99 00.

C. Calibration

1. Calibrate analysis instruments, sensors, gages, and meters installed under this contract on a system-by-system basis.
2. Do not perform any equipment or system Performance Tests until instruments, gauges, and meters to be installed in that particular system have been calibrated and the calibration work has been witnessed by the Engineer.

3. Calibrate testing equipment in accordance with the manufacturer's instructions. Execute and submit completed Instrumentation Data Sheet and Calibration Test Data Form found in Section 01 99 00.

D. Mechanical Systems

1. Manufacturer's representatives shall confirm that all equipment and valves are properly installed before first operation and shall conduct/oversee the initial operation and testing.
2. Test all mechanical systems as specified in the individual equipment specification sections and as follows:
 - a. Ensure and demonstrate that equipment and valves operate properly and reliably. Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.
 - b. Inspect hand and motorized valves for proper adjustment. Tighten packing glands to insure no leakage, but permit valve stems to rotate without galling. Verify valve seats are positioned for proper flow direction.
 - c. Tighten leaking flanges or replace flange gasket. Inspect screwed joints for leakage.
 - d. If equipment that is capable of automatic or remote operation, test it first in manual mode.
 - 1) Set and adjust limit switches on all valves so equipped.
 - 2) Confirm set-points on all pressure regulating, pressure relief, vacuum relief, and other valves with set-points and reset as directed by the Engineer.
 - e. Remove rust preventatives and oils applied to protect equipment during construction.
 - f. Flush lubrication systems and dispose of flushing oils. Recharge lubrication system with lubricant recommended by manufacturer.
 - g. Flush fuel system and provide fuel for testing and start-up.
 - h. Install and adjust packing, mechanical seals, O-rings, and other seals. Replace defective seals.
 - i. Remove temporary supports, bracing, or other foreign objects installed to prevent damage during shipment, storage, and erection.
 - j. Check rotating machinery for correct direction of rotation and for freedom of moving parts before connecting driver. Turn rotating equipment by hand when possible to confirm that equipment is not bound.
 - k. Perform cold alignment and hot alignment to manufacturer's tolerances.
 - l. Adjust V-belt tension and variable pitch sheaves.
 - m. Startup tests of pumps, motors, and VFD's shall be performed to verify pump performance and operation over the full operating range from minimum head/flow up to maximum head/maximum capacity.
 - n. Install gratings, safety chains, handrails, shaft guards, and sidewalks prior to Facility Startup/Operational Testing.

E. Electrical Systems

1. Perform testing in three stages as specified in the individual equipment specification sections and as follows:
 - a. The first stage of field testing shall consist of electrical equipment testing prior to energization and operation of electrical equipment.

- b. Prior to equipment startup, conduct testing, calibration, and setting of electrical conductors, equipment, protective devices, grounding, and other components as specified. This also includes bumping all motors to verify the direction of rotation. If equipment test results are unsatisfactory, repair and re-test until acceptable results are obtained, at no additional cost to the Owner.
 - c. The second stage of electrical testing shall occur after energization and start-up of equipment and shall consist of complete testing of all other equipment as specified in the Electrical Sections by the Contractor.
 - d. The third stage of testing will take place during the Operational Testing and shall include all possible operating scenarios, alarm conditions, prohibitive interlocks, and indication functions as well as witnessed instrument and PLC I/O testing in conjunction with PLC and SCADA program testing under observed conditions.
- F. Instrumentation
 - 1. Conduct field calibration, loop acceptance, and end-to-end testing as specified in the individual Instrumentation Sections.
 - 2. Bench or field calibrate instruments and make required adjustments and control point settings.
 - 3. Energize transmitting and control signal systems, verify proper operation, ranges, and settings.
 - 4. Demonstrate proper operation of each instrument loop function including alarms, local and remote controls, instrumentation and other equipment functions.
 - 5. Generate signals with test equipment to simulate operating conditions in each control mode.
- G. Permanent Utilities
 - 1. Conduct Performance Tests on utilities impacted, constructed, or modified by construction, as specified in the applicable Sections.
- H. HVAC Systems
 - 1. Balance HVAC systems, measuring airflow (cfm) static pressure, and component pressure losses.
 - 2. Furnish written report documenting results of balancing.
- I. Demonstration
 - 1. Demonstrate proper rotation, alignment, speed, flow, pressure, vibration, sound level, adjustments, and calibration over the full operating range of equipment and systems.
 - 2. Perform initial checks in the presence of and with the assistance of the manufacturer's representative.
- J. Telecommunications System Testing
 - 1. Test telecommunications as specified.
 - 2. The communications networks shall be fully operational and certified prior to starting the demonstration period.

3.6 TEST RESULTS

- A. Test results shall be within the tolerances stated in the individual Specification sections. If no tolerances have been specified, test results shall conform to tolerances established by

recognized industry practice. When, in Engineer's opinion, equipment meets performance requirements specified, such equipment will be accepted as to conforming with Contract requirements. Such acceptance will be evidenced by Engineer's signature on the Equipment Test Report (Section 01 99 00).

- B. Should any doubt, dispute, or difference arise between the Engineer and the Contractor regarding the test results or the methods or equipment used in the performance of the testing, then the Engineer may order the test to be repeated. If the repeat test, using such methods or equipment as the Engineer requires, substantially confirms the previous test, then all costs in connection with the repeat test will be paid by the Owner, otherwise the costs shall be borne by the Contractor. All costs associated with repeat testing due to failed test results shall be borne by the Contractor, including the Engineer's expenses.
- C. If any portion of the work should fail to fulfill the contract requirements and is adjusted, altered, renewed, or replaced, tests on that portion of the work together with all other affected portions of the work, shall, be repeated within reasonable time and in accordance with the specified requirements. The Contractor shall pay to the Owner all reasonable expenses incurred by the Owner, including the costs of the Engineer, as a result of repeating such tests.

3.7 POST TEST INSPECTION

- A. Once Performance Testing has been completed, recheck all machines for proper alignment and realigned, as required.
 - 1. Check all equipment for loose connections, unusual movement, or other indications of improper operating characteristics.
 - 2. Correct any deficiencies to the satisfaction of the Engineer.
- B. If any machine or device exhibits unusual or unacceptable operating characteristics, disassemble and inspect it.
 - 1. Any defects found during the course of the inspection shall be repaired or the specific part or entire equipment item shall be replaced to the complete satisfaction of the Engineer, at no cost to the Owner.

3.8 MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

- A. Upon completion of Performance Testing and prior to Facility Startup/Operational Testing, submit the Manufacturer's Installation Certification Form, found in Section 01 99 00, signed by the manufacturer's authorized representative and certifying that the equipment:
 - 1. Has been properly installed, adjusted, aligned, and lubricated.
 - 2. Is free of any stresses imposed by connecting piping or anchor bolts.
 - 3. Is suitable for satisfactory full-time operation under full load conditions.
 - 4. Operates within the allowable limits for vibration.
 - 5. Controls, protective devices, instrumentation, and control panels furnished as part of the equipment package are properly installed, calibrated, and functioning.
 - 6. Control logic for start-up, shutdown, sequencing, interlocks, and emergency shutdown have been tested and are properly functioning.
 - 7. Also submit the Manufacturer's Installation Certification Form, signed by the electrical and/or instrumentation Subcontractor certifying:
 - a. Control logic that resides in motor control centers, control panels, and circuit boards furnished by the electrical and/or instrumentation subcontractor has been calibrated and tested and is properly operating.

- b. Control logic for equipment start-up, shutdown, sequencing, interlocks and emergency shutdown has been tested and is properly operating.
- B. The Contractor shall co-sign the Manufacturer's Installation Certification Form along with the manufacturer's representative and Subcontractors and deliver the reports to the Engineer prior to Facility Startup/Operational Testing.

3.9 TRAINING

- A. Conduct the training of the Owner's staff as specified for equipment and facility operation and maintenance before each associated system is placed into service. Refer to **Section 01820** for specific requirements.

3.10 FACILITY STARTUP AND OPERATIONAL TESTING

- A. After completion of all Performance Testing and operator training, initiate Facility Startup and Operational Testing of each system.
- B. Conduct the Operational Testing for a continuous seven (7) day period.
- C. Provide Subcontractor and equipment manufacturers' staff adequate notice to prevent delays.
- D. Facility Startup and Operational Testing Plan
 - 1. Develop a plan in conjunction with Owner's operations personnel detailing step-by-step instructions for startup of each unit process and the complete facility.
 - 2. Include a method of evaluation and overall performance reports for each unit process, utilizing the Startup and Performance Evaluation Form found in Section 01 99 00. Use one form for each unit process. Startup and Performance Evaluation Forms will minimally include the following:
 - a. Description of unit process being started.
 - b. All equipment and devices included in the unit process.
 - c. Unit process startup procedures (i.e., valves to be open/closed, order of equipment startup, etc.).
 - d. Requirements for water, power, chemicals, etc. needed for startup.
 - e. Space for performance evaluation comments (this portion of the form will be filled out during the Demonstration Periods).
- E. Owner's Responsibilities
 - 1. Assist Contractor in developing a Facility Startup and Operational Testing Plan detailing step-by-step instructions for startup of each unit process and the complete facility.
 - 2. Provide water and power for testing and facility startup, unless otherwise indicated.
 - 3. Operate process units and devices, with support of Contractor.
 - 4. Provide labor and materials as required for sampling and laboratory analyses.
- F. Facility Startup and Operational Testing Period
 - 1. Startup sequence of the unit processes shall be in accordance with the Facility Startup and Operational Testing Plan developed by the Contractor and the Owner, and as approved by the Construction Manager.
 - 2. Startup of the entire facility or any portion thereof shall be considered complete when, in the opinion of the Construction Manager, the facility or designated portion has operated in manner intended for seven (7) continuous days, without

interruption, unless otherwise specified. This period is in addition to operator training and Performance Test periods specified elsewhere.

3. Repeat Operational Testing when malfunctions or deficiencies cause shutdown or partial operation of the facility or results in performance that is less than specified, as determined by the Construction Manager. Any interruption will require the startup then in progress to be stopped and restarted for an additional seven (7) continuous days, after corrections are made.

G. Facility Performance Evaluation

1. During the Demonstration Periods, the Owner will conduct a performance evaluation to determine the full capabilities of the facility and performance of the computer system, until all unit processes are operable and under control of the computer system.
2. The Contractor shall be available to witness the performance evaluation of the equipment so that the Contractor can certify, on the Startup and Performance Evaluation Forms in Section 01 99 00, that each unit process is capable of performing its intended function(s), including fully automatic and computerized operation.

3.11 DEMONSTRATION PERIODS

- A. After successful completion of Performance Testing, Facility Startup and Operational Testing and when the Owner is ready to accept the applicable systems, the applicable systems shall be placed into full operational condition and enter a 20-day Demonstration Period.
- B. The Contractor shall be responsible for the development of an outline of the steps for the start-up and initial operation of each area under actual operating conditions of the equipment and systems and to provide direction to the Owner's operations personnel. The document shall be reviewed and approved by the Owner and shall serve as guidance for the Demonstration Periods.
- C. The Owner's certified operations personnel shall operate the facility with direction, technical and maintenance support of the Contractor for each Demonstration Period.
 1. The Contractor shall be available within 24-hours' notice to provide repairs, assistance, or adjustments in case of failure of any portion of the system.
- D. During each Demonstration Period, the Owner shall be responsible for all normal operational costs and the Contractor shall bear the costs of all necessary repairs or replacements, including labor and materials.
- E. Owner reserves the right to simulate operational variables, equipment failures, routine maintenance scenarios, etc., to verify the functional integrity of the system.
- F. The facility shall be fully operational, performing all functions for which it was designed and shall meet the performance requirements of each individual equipment specification Section. If, during each of the Demonstration Periods the aggregate amount of time used for repairs, alterations, or unscheduled adjustments to any equipment or systems that renders the affected equipment or system inoperative or unable to perform all functions for which it was designed exceeds 10-percent of the Demonstration Period time, then the Demonstration Period will be deemed to have failed.
 1. In the event of failure, a new Demonstration Period will recommence after correction of the cause of failure.
 2. Any new Demonstration Periods shall have the same requirements and durations as the first period.

- G. Time of beginning and ending of the Demonstration Period shall be agreed upon by the Contractor, Owner and the Engineer, in advance of initiating the Demonstration Period.
- H. Upon completion of the Demonstration Periods, and when all corrections required by the Engineer to assure a reliable and completely operational facility are complete and all test reports have been submitted and approved, the Construction Manager shall issue a Certificate of Substantial Completion for the associated Demonstration Period.

END OF SECTION

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SECTION 02 21 13 – SURVEY MONUMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes furnish and install Cast-in-place Portland Cement Survey Monuments and all appurtenant work.
- B. Related Requirements:
 - 1. [Section 03 30 00 – Utility Cast-in-place Concrete](#)
 - 2. [Section 31 23 16 – Utility Trenching](#)

1.2 UNIT PRICE - MEASUREMENT AND PAYMENT

- A. [Section 01 29 00 - Payment Procedures](#): Contract Sum/Price modification procedures.
- B. Survey Monuments
 - 1. Basis of Measurement: Measured on a per unit basis.
 - 2. Basis of Payment: Includes concrete, placement accessories, consolidating, leveling, troweling, and curing.

1.3 REFERENCE STANDARDS

- A. ASTM International:
 - 1. ASTM A48 – Specifications for Gray Iron Castings
- B. Caltrans Standard Specifications
 - 1. Section 55 – Steel Structures
 - 2. Section 78-2 – Survey Monuments

1.4 COORDINATION

- A. Coordinate placement of concrete formwork and placement of form accessories.

1.5 SUBMITTALS

- A. [Section 01 33 00 - Submittal Procedures](#): Requirements for submittals.

- B. Product Data: Submit data on bronze survey markers, frame and covers.

1.6 CLOSEOUT SUBMITTALS

- A. [Section 01 78 00 - Closeout Submittals](#): Requirements for submittals.

PART 2 - PRODUCTS

2.1 FRAME AND COVER

- A. Monument frame and cover shall be gray iron castings conforming to ASTM A48, Class 30B, designed for a 15,000 lb. wheel load. Monument cover shall be marked "Monument". Cover shall be non-rocking and will fit in its frame.
- B. Monument Frame and Cover shall be Chrisp Company Casting Part No.9279 or 9277M, Phoenix Iron Works 2501 or approved equal.

2.2 BRONZE SURVEY MARKER

- A. Bronze survey marker shall be 2-1/2 inch domes disk with stem and appropriate survey information as specified on the Drawings.
- B. Brass Survey markers are not acceptable unless they are lead-free.

2.3 FORMING TUBE

- A. Tubes for forming Portland cement concrete collar and monument shall be non-metallic type of the size and dimensions shown on the Drawings.

2.4 PORTLAND CEMENT CONCRETE

- A. Portland Cement Concrete for collars and footings shall conform with [Section 03 30 00 – Utility Cast-in Place Concrete](#).

2.5 HOT MIX ASPHALT

- A. Hot Mix Asphalt concrete around monuments shall be in conformance with [Section 32 12 16 – Asphalt Paving](#).

PART 3 - EXECUTION**3.1 GENERAL**

- A. [Section 01 70 00 - Execution](#): Requirements for installation examination.
- B. Monuments shall not be installed until the asphalt paving has been completed.
- C. Concrete, form tube, bronze survey marker, frame and cover, and asphalt paving shall be installed as shown on the Drawings.
- D. Cast the monuments in place in neat holes using forming tubes.
- E. Thoroughly consolidate the concrete and cure it by the water method per Section 90-1.03B (2) Water Method of State Standard Specifications.
- F. Locate the monument such that the point being referenced falls within 1/2-inch from the center of the disk when the disk is placed in the center of the monument.
- G. Place the survey marker disk before the concrete reaches its initial set. Firmly embed the disk in the concrete.
- H. If base and surfacing are not shown around a monument, fill any space around it with earth. Water and tamp the earth into place.
- I. Surplus excavated material shall become the property of the Contractor and the Contractor shall be responsible for disposal of excess excavated material.
- J. The Concrete collar shall be circular – 8 inches in diameter around the frame and cover and shall be covered with a minimum of two (2) inches of asphalt concrete paving to level with the adjacent surfacing.

3.2 EXISTING MONUMENT PROTECTION

- A. All existing survey monuments and benchmarks shall be protected, unless otherwise shown on the Drawings. Upon discovery of a survey monument not identified and located by the City, immediately:
 - 1. Stop work near the monument
 - 2. Notify the Project Manager
- B. Do not resume work near the monument until authorized by the Project Manager.
- C. Monuments placed by Surveyors must be preserved, in accordance with State Business & Professions Code section 8771.
- D. The Contractor shall exercise caution when working around monuments so as not to disturb them. During milling, grinding, excavation or other operations, the

Contractor shall work around survey monuments unless specifically otherwise indicated on the Plans. If a monument is disturbed or damaged during adjusting, milling or other operations, the Contractor shall be responsible for all costs associated with the reestablishment of the monument including but not limited to surveying performed by a Licensed Surveyor and filing documents with County and constructing the new monument.

- E. The existing monument consisting of a concrete core and brass tack, nail or other marking device located inside of a survey monument cover with frame, shall not be disturbed until the contractor's Licensed Land Surveyor has established of reference points to preserve the location of the monument, in accordance with State Business & Professions Code section 8771.
- F. Any survey monument disturbed shall be replaced in accordance with the State Business & Professions Code section 8771 and Contra Costa County Standard Drawings CA40. The Contractor shall be responsible for all costs associated with the reestablishment of the monument including but not limited to surveying performed by a Licensed Surveyor and filing documents with County and constructing the new monument.
- G. Contractor shall prepare corner record, submit corner record to the County Surveyors and submit acceptance of monument to the Project Manager.

3.3 CONCRETE PROTECTION

- A. The Contractor shall protect all concrete against injury until final acceptance by the City.

END OF SECTION 02 21 13

SECTION 02 32 19 – EXPLORATORY EXCAVATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Exploratory excavation by potholing at all utility conflicts including the locations identified on the plans to determine the location, depth, width, pipe diameter or concrete ductbank thickness, type and condition of existing underground utilities.

1.2 REFERENCES

- A. Cal/OSHA – California Division of Occupation Safety and Health
- B. Caltrans Standard Specifications
 1. Section 15 – Existing Facilities
 2. Section 19 - Earthwork
- C. Underground Services Alert (USA)

1.3 SUBMITTALS

- A. [Section 01 33 00 - Submittal Procedures](#): Requirements for submittals.
- B. Submittal Data:
 1. Contractor shall contact USA to verify the actual location of the pothole prior to beginning pothole. Submit letters or correspondences of advance notifications to the utility companies as listed below in Part 3.
 2. Contractor shall apply and pay for all permits connected with the Work.
 3. Contractor shall submit temporary traffic control plan for City's approval prior to beginning any exploratory excavation.
 4. Contractor shall submit potholing methodology.
 5. Contractor shall submit photographs in jpeg or PDF format of the pothole locations with the pothole number identified on the photograph as designated below.
 6. Pothole data shall also include the thickness of asphalt concrete/Portland cement concrete pavement and aggregate base.

7. At a minimum, pothole data shall be submitted in a tabular format. See sample potholing submittal format below:

#	Utility	Pipe diameter (inch)	Concrete ductbank Width x Depth	Depth to top of pipe or concrete ductbank	Material	AC/AB Depth (inch)	Northing or Distance from fixed object A	Easting or Distance from fixed object B
PH#1	Water	12	-	3'-6"	PVC	4/8	15 ft from FH	12 ft from SSMH
PH#2	Telecom Duct	-	2 ft x 3 ft	4'-2"	Concrete Ductbank	6/10	22 ft from SDMH	40 ft from WV

1.4 MEASUREMENT & PAYMENT

- A. Measurement: For measurement of Exploratory excavations (potholing) performed by the Contractor, an exploratory excavation (potholing) will be counted as complete when the intended pipe is exposed, measured, the data has been submitted in the tabular format as specified above, reviewed and approved by the Project Manager, the pothole is backfilled and the surface restoration including any striping is restored. Empty potholes will not be counted as complete.
- B. Payment: The Contract unit price paid for Exploratory Excavations (potholing) shall include full compensation for furnishing all labor, tools, equipment's, incidentals for exploratory excavations by potholing to verify the location, depth, diameter, material and thickness of the existing underground utility, including contacting USA, utility companies, permits, traffic control, compliance with Cal/OSHA, saw cut, excavation, exposing the existing underground utility, measuring depths, diameter and distances as required, backfill, surface restoration, striping restoration, submitting the pothole data in a tabular format for review and approval by the Project Manager, as shown on the Drawings, as specified in the City Standard Specifications and as directed by the Project Manager.
- C. Full compensation pay clause for furnishing all labor, tools, equipment's, incidentals for exploratory excavations by potholing for any utility conflicts not identified on the Drawings including exploratory excavations by potholing to verify the location, depth, diameter, material and thickness of the existing underground utility, including contacting USA, utility companies, permits, traffic control, compliance with Cal/OSHA, saw cut, excavation, exposing the existing underground utility, measuring depths, diameter and distances as required, backfill, surface restoration, striping restoration, shall be considered as incidental

to the item most closely related to and no separate compensation will be allowed therefor.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 POTHOLING

- A. Contractor shall be responsible for notifying the utility companies for any inspections prior to potholing.
- B. Contractor shall be responsible for locating utilities and providing utility markings of the underground utilities prior to potholing.
- C. Where gas distribution or gas transmission lines are present, Contractor shall have a PG&E representative present on site during potholing.
- D. Contractor shall be responsible for contacting and notifying the utility companies three (3) working days prior to beginning any potholing. Contractor shall be responsible for coordinating any inspections with the respective utility company.
- E. Two (2) weeks prior to any construction, potholing shall be performed at all utility conflicts and at all pothole locations shown on the Drawings in order to determine the location, depth, width, pipe diameter, thickness type and condition of existing underground utilities and shall conform to the Technical Specifications.
- F. Potholing will be a separate move-in from the underground utility trenching and will be separate from the trenching operations; Exploratory excavations shall be performed with potholing equipment. Potholing as part of the trenching operations is not an acceptable method. Potholing will be shown as a separate line item in the project construction schedule.
- G. The methods such as vacuum potholing and other excavation methods used by the Contractor for potholing shall be approved by the Project Manager in advance of commencing any work, along with the required traffic controls.
- H. After the completion of the USA markings, but before the actual potholing, Contractor will host a field meeting with the City to review the locations of the potholes which will be painted in the field. During the meeting, the Project Manager may relocate the potholes based on the field conditions. The Contractor's price bid will include allowance for moving the locations of the

potholes during the pre-pothole site meeting. No guarantee is made as to the exact locations of the existing utilities.

- I. The Contractor shall provide the Project Manager in a tabular format the location, type, depth, diameter and condition of each utility found prior to commencing construction. The potholing table shall include a neatly redlined plan. No trenching work shall be performed until the Project Manager reviews the potholing information submitted by the Contractor.
- J. Contractor shall provide the potholing information to the Project Manager and allow one (1) week for any necessary revisions to the design plan and profiles prior to sawcutting and trenching of the proposed pipe alignment or as shown on the Drawings.
- K. The Contractor shall take care not to damage any existing facilities during potholing. Existing facilities damaged by the Contractor's operations shall be repaired or replaced to the satisfaction of the City Engineer and Utility companies, all at the Contractor's expense.
- L. Backfill with Controlled Low Strength Materials (CLSM) and complete surface restoration to match existing conditions in kind.
- M. When pothole locations are located in concrete pavement, Contractor shall remove and replace concrete pavement and base from the nearest joint to joint to match the existing concrete pavement thickness.

END OF SECTION 02 32 19

SECTION 02 41 00 - DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes but not limited to:
 - 1. Demolition & Permits
 - 2. Removal and Disposal
 - 3. Recycling & Salvaging

1.2 UNIT PRICE - MEASUREMENT AND PAYMENT

- A. Demolition:
 - 1. Basis of Measurement: Not a measured item, unless specified otherwise on the Drawings.
 - 2. Basis of Payment: The Contract lump sum price paid for "Demolition" shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals for doing all work involved in Demolition, including obtaining demolition permits, permit fees, sawcut, remove asphalt and concrete paving and base to design subgrade, remove foundation and base; terminating and removing utilities to be demolished and other items of work as specified in the plans, Standard Specification and the Technical Specifications, and as directed by the Project Manager.

1.3 REFERENCES & RELATED WORK SPECIFIED ELSEWHERE

- A. Bay Area Air Quality Management District (BAAQMD) – <http://www.baaqmd.gov/>
 - 1. Regulation 11 (Hazardous Pollutants) and Rule 2 (Asbestos Demolition, Renovation, and Manufacturing).
- B. CALGreen Construction Waste Management Requirements
 - 1. https://www.calrecycle.ca.gov/lqcentral/library/canddmodel/instruction/new_structures
- C. California Occupational Safety and Health (Cal/OSHA)
 - 1. General Requirements
- D. Commercial
 - 1. USA Underground Service Alert
- E. Division 1
 - 1. General Requirements

1.4 SUBMITTALS

- A. [Section 01 33 00 - Submittal Procedures](#): Requirements for submittals.
- B. The Contractor shall submit to the City a haul route for approval, prior to commencing any work. Truck traffic movement is limited between the hours of 9am to 3pm, unless approved by the Project Manager.
- C. Before disposing of any demolished material prior to any work
 - 1. Submit a written agreement from the property owner
 - a. For the use of the property
 - b. absolving the City from responsibility in connection with the property.
 - 2. Obtain authorization to start
- D. Before Contract acceptance, submit a document signed by the owner of the material disposal site stating that the Contractor has complied with the Contractor-Owner agreement.
- E. Demolition Schedule: The Contractor shall submit a complete coordination schedule for demolition work including shut-off and continuation of utility services prior to start of the work. The schedule shall indicate proposed methods and operations of facility demolition, and provide a detailed sequence of demolition and removal work to ensure uninterrupted operation of occupied areas.
- F. All affected private properties will receive door hanger notices two (2) weeks prior to any utility shutoffs or frontage demolition and improvements.

1.5 JOB SITE CONDITIONS

- A. The Contractor shall visit the site and inspect the existing facilities. The City assumes no responsibility for actual condition of facilities to be demolished.
- B. Contractor shall use all means necessary to prevent the spread of dust during performance of the work. Thoroughly moisten all surfaces as required to prevent the generation of dust. No washing of streets is permitted.
- C. All liquid, and slurry generated during pavement sawcutting shall be collected and removed from the site. These liquids shall not be washed into the area storm drainage system.
- D. Contractor shall remove hazardous materials as described per the Project Asbestos and Lead Inspection Report.
- E. The Contractor prior to the commencement of the demolition or renovation, thoroughly inspect the affected facility or part of the facility where the demolition or renovation operation will occur for the presence of asbestos, including Category I and Category II nonfriable Asbestos Containing Materials (ACM).

- F. The Contractor must also provide the Environmental Protection Agency (EPA) with a 10 working day advance notice for any disturbance of Regulated Asbestos-Containing Material (RACM) greater than 160 square feet or 260 lineal feet, and as specified in Code of Federal Regulations (CFR) Title 40, Chapter I, Subchapter C, Part 61, Subpart M, Section 61.145.

1.6 DELIVERY, STORAGE AND HANDLING

- A. [Section 01 60 00 - Product Requirements](#): Requirements for transporting, handling, storing, and protecting products.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Notify anyone to be affected by demolition and construction activities including but not limited to: all schools, residences, businesses, garbage collection (Pittsburg Disposal Service-a Garaventa company), utility companies (PG&E-Gas Distribution, PG&E Gas Transmission, PG&E-Electric, AT&T, Comcast, Verizon, Chevron Pipeline Co, Shell Pipeline Co, Kinder Morgan, Calpine etc.), Delta Diablo (Sewer District), BART, County Connection (bus transit agency), the Owner, etc. at least ten (10) working days prior to commencing the work of this section.
- B. Site Inspection:
 - 1. Prior to all work of this section, carefully inspect the site and all objects designated to be removed and to be preserved.
 - 2. Locate all existing active utility lines traversing the site and determine the requirements for their removal and/or protection.
- C. Clarification:
 - 1. The Drawings do not purport to show all objects existing on the site.
 - 2. Before commencing the work of this section, verify with the Owner all objects to be removed and all objects to be preserved
- D. Scheduling:
 - 1. Schedule all work in a careful manner with all necessary consideration for neighbors, operation of the existing facilities, and the public.
 - 2. Avoid interference with the use of, and passage to and from, residences and adjacent facilities.

- E. Protection of Utilities: Preserve in operating condition all active utilities traversing the site and designated to remain.

3.2 WATER POLLUTION CONTROL

- A. Water sprinkling, temporary enclosures, chutes and other suitable methods shall be used to limit dust and dirt rising and scattering in the air. The Contractor shall comply with all government regulations pertaining to environmental protection.
- B. The Contractor shall use equipment that will generate the least amount of dust. The Contractor shall provide dust control at all times including Saturdays, Sundays, and holidays unless directed otherwise by the Project Manager.
- C. Whenever the Contractor, in the opinion of the Project Manager, is negligent in controlling dust, the Project Manager may direct attention to the existence of a dust hazard and instruct the Contractor to immediately alleviate the dust hazard. The Contractor shall be responsible for any damage cause by dust generated as a result of the Contractor's operations.
- D. The Contractor shall have a commercial standard street vacuum/sweeper operational and in operation during each working day. The street vacuum/sweeper shall be able to pick up sand, gravel, dust, and debris, and other things, shall minimize dust generation, and shall also be available during the day and shall sweep as outlined below and as directed by the Project Manager.
- E. If the Contractor is performing work that generates dust and debris then during the day (including weekends and holidays) the sweeper shall sweep the project area (full length, width, and all lanes) twice a day sometime between 9:00a.m. and 11:00a.m. and also between 2:00p.m. and 4:00p.m. Hardscape surfaces (including pavers, sidewalks, and areas inaccessible by a mechanical sweeper) shall have dirt, dust, and debris removed by hand sweeping. If the Contractor fails to fulfill the responsibilities of this section, the City will perform or contract with others to perform the work and all costs incurred to the City shall be withheld from future payments to the Contractor.
- F. The Contractor shall clean the sidewalk and gutter as many times as needed to make sure the sidewalk and gutter are out of dirt, debris and small rocks at all times. The Contractor shall be prepared to sweep surfaces immediately at the request of the Project Manager, should the Project Manager deem it necessary for public safety and to avoid damage to properties. If streets are not satisfactorily cleaned within 12 hours from verbal or written notice by City personnel, the City will hire an independent sweeping company and deduct the cost for such work from payments due to the Contractor.
- G. Water shall not be used in a manner that creates hazardous or objectionable conditions such as ice, flooding, or pollution.

- H. The site shall be kept neat and orderly during the demolition to the maximum extent practical.
- I. Public right-of-way and private property shall be kept free of debris at all times.
- J. Stockpiles of demolished items or materials shall be removed from the site on a daily basis or stored in waste containers which shall be emptied on a weekly basis or as conditions require in order to manage the accumulation of waste.
- K. Accumulations of flammable materials shall not be permitted.

3.3 PROTECTION

- A. Safe passage of persons around area of demolition shall be provided in accordance with all safety and regulatory requirements. Operations shall be conducted to prevent damage to adjacent buildings, structures, other facilities, people and property. Safe passage provided by Contractor will be ADA complaint.
- B. Interior and exterior shoring, bracing, or supports shall be provided to prevent movement, settlement or collapse of structures to be demolished and to adjacent facilities to remain.
- C. Existing landscaping materials, structures, and appurtenances which are not to be demolished shall be protected and maintained as necessary.
- D. The Contractor shall protect and maintain conduits, drains, sewers, pipes and wires that are not to be demolished.
- E. Use all means necessary to protect existing objects designated to remain or to be preserved must remain operational during installation of the replacement pipeline. In the event of damage, immediately notify the Owner and make all repairs and replacements necessary for approval by the Owner at no additional cost to the Owner.

3.4 SURFACE DEMOLITION

- A. All asphalt concrete and all Portland cement concrete curbs, gutters, sidewalks, access ramps and driveways shall be saw-cut at the nearest scoreline or deep joint and removed entirely to the saw-cut limits.
- B. Where adjacent pavement or concrete is broken or damaged sufficiently to prohibit a sound replacement the entire damaged section shall be removed to the limits determined by the Project Manager.

- C. Asphalt concrete, sidewalk, concrete curb, and gutter materials to be demolished shall be broken up and removed from the site by the Contractor at no additional cost to the City.
- D. Where shown on the Drawings, the Contractor shall remove required pavement section including base material. Subsoil removal is also included where required to achieve design subgrade.

3.5 DEMOLITION BELOW THE SURFACE

- A. Existing structures, pavement slabs and structural sections to be abandoned shall be demolished to an elevation three feet below finished grade. Their bottoms (if any remain) shall be broken thoroughly to prevent entrapment of water and all voids backfilled with suitable backfill
- B. Demolition areas and voids resulting from demolition of structures below the surface shall be completely filled.
- C. All fill, compaction, and holes created by demolition work shall be backfilled with imported clean fill. Lay fill down in layers not exceeding 6" thickness and compact per the earthwork specifications. Grade the site to drain to the nearest storm drainage system without any low points.
- D. All fill and compaction surfaces shall be graded to meet adjacent contours and to provide flow to surface drainage structures, or as shown on the Drawings.
- E. Pipes to be demolished that require no future connection shall be removed to the extent required, sealed and capped. Pipe sections shall be removed either by sawcutting, removing a complete pipe section to an existing joint, or other adequate means which results in a clean joint.
- F. The Contractor shall demolish or dismantle and remove all items that are noted for demolition and removal in the Contract Documents and that will interfere with the planned construction, or as otherwise directed by the Project Manager.
- G. The Contractor shall demolish or dismantle and remove all abandoned conduits or structures that are encountered during the prosecution of the work and which interfere with the construction of the work upon the approval of the Project Manager.

3.6 REMOVAL OF EXISTING WATER AND SEWER-SERVICES

- A. The Contractor shall submit to the City for approval a detailed sequence and method of work for staking, abandonment of existing sewer services, water services, water meters, boxes, and cleanouts. The submittal shall include an

overview and general sequence of work; time and dates for each removal; and method and procedure for each removal.

B. ABANDONMENT OF SEWERS:

1. Contractor shall request an encroachment permit with Delta Diablo (District) for abandoning any existing sanitary sewer lateral pipes.

C. ABANDONMENT OF WATER LINES:

1. For service lines less than 4" diameter:
 - (a) Contractor shall pothole, cut out at the main, remove the corporation stop and saddle, and install a minimum 12" full circle 316 stainless steel repair clamp with 316 accessories around the pipe.
 - (b) Abandon unused existing water service lines in place, if at least 18" below grade to the Project Manager's satisfaction.
2. Contact City Water Department in writing 48 hours in advance of abandonment, to check the condition of the existing services prior to abandonment.

D. GENERAL ABANDONMENT:

1. When salvage materials are shown on the Drawings; salvage and arrange the existing facilities (i.e., meters, manhole covers, manhole frames, etc.) to be dropped off at the City's Corporation Yard by prior arrangement.
2. Properly remove or abandon in place unused existing City utility service lines discovered that were left in place by others.
3. Contact utility companies for removal, abandonment, adjustment or relocation of their facilities.
4. Contractor is responsible for verifying the location of any existing utilities.
5. Abandonment of pipes will include filling pipe with slurry as specified in Section 19-3.02G – Controlled Low-Strength Material of the State Standard Specification and capping the pipes at the ends.

3.7 DISPOSAL OF DEMOLISHED MATERIALS

- A. See [Section 01 74 19 – Construction Waste Management and Disposal](#) for disposal, salvaging and recycling of demolished materials.
- B. Demolition and removal of debris shall be conducted to ensure minimum interference with roads, streets, walks and other adjacent occupied or used facilities which shall not be closed or obstructed without permission from the City. Alternate routes shall be provided to circumvent closed or obstructed traffic ways.
- C. The Contractor shall comply with all pertinent regulations of Cal/OSHA and local codes and practices.
- D. All existing materials that are designated to be salvaged shall be removed, cleaned and hauled to the City Corporation Yard, unloaded and stockpiled unless otherwise directed by the Project Manager.

- E. Site debris, rubbish and other materials resulting from demolition operations shall become the property of the Contractor and shall be removed by the Contractor at the Contractor's expense. The proper and legal disposal of demolished materials shall be the responsibility of the Contractor. All disposal sites and recycling facilities shall be approved by the City prior to initiation of the Work.
 - 1. Concrete debris shall be transported to a recycler of such materials.
 - 2. Hazardous materials shall be handled and disposed of in accordance with all applicable laws, codes, and regulations.

3.8 PATCHING AND REPAIRING

- A. The Contractor shall provide patching, replacing, repairing and refinishing of damaged areas or damaged adjacent facilities involved in the demolition.
- B. New concrete shall match the existing adjacent surfaces, in kind, or of better quality, to the satisfaction of the Project Manager, at no cost to the City or to the owners of the facilities.

3.9 CLEAN UP

- A. During and upon completion of work the Contractor shall promptly remove unused tools and equipment, surplus materials, rubbish, debris and dust and shall leave areas affected by work in a clean, approved condition.
- B. The Contractor shall clean adjacent structures and facilities of dust, dirt and debris caused by demolition, as directed by the Project Manager, and return adjacent areas to condition existing prior to start of work.
- C. The Contractor shall clean and sweep daily all street and roads affected by its operation.

END OF SECTION 02 41 00

SECTION 03 10 00

CONCRETE FORMS AND ACCESSORIES

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required, and design, install, and remove formwork for cast-in-place concrete as shown on the Drawings and as specified herein.
- B. Secure to forms as required or set for embedment as required, all miscellaneous metal items, sleeves, reglets, anchor bolts, inserts, and other items furnished under other Sections and required to be cast into concrete.

1.02 RELATED SECTIONS

- A. Section 03 15 00 – Concrete Joints and Accessories
- B. Section 03 21 00 – Concrete Reinforcement
- C. Section 03 30 00 – Cast-in-Place Concrete
- D. Section 03 60 00 – Grouts
- E. Section 03 92 20 – Modifications and Repairs to Concrete

1.03 SUBMITTALS

- A. Submit shop drawings and product data showing materials of construction and details of installation for the following:
 - 1. Form release agent
 - 2. Form ties
 - 3. Void forms
- B. Certify that form release agent is NSF International/American National Standards Institute (NSF/ANSI) Standard 61 compliant, with certification from an independent ANSI/Environmental Laboratory Accreditation Program (ANSI/ELAP)-accredited testing laboratory acceptable to the Engineer but engaged by and at the expense of the Contractor.
- C. Falsework and Drawings - The Contractor will adhere to the provisions of Section 1717 of the Division of Industrial Safety, Construction Safety Orders, which require that all falsework or vertical shoring installations where the height of the falsework or vertical shoring, as measured from the top of the sills to the soffit of the superstructure, exceeds 14 feet, or where individual horizontal span lengths exceed 16 feet, or provision for vehicular or railroad traffic through falsework or vertical shoring is made, shall be approved and signed by a Professional Civil or Structural Engineer, registered in the State of California. A copy of the falsework plan or shoring layout shall be available on the job site at all times.
- D. The Contractor shall submit detailed plans of falsework proposed to be used. Such plans shall be in sufficient detail to indicate the general layout, sizes of members, anticipated stresses, grade of materials to be used in the falsework, and typical soil conditions.
- E. Location and sequence of the concrete placement - Indicate locations of form joints, form-tie layout, and panel sizes and patterns. Show location of form ties on architectural surfaces.

F. Review of pour sequence, form system and panel layout shall be for appearance and conformance to design concept only. Engineer's review of the forming plans or procedures shall not relieve the Contractor of responsibility for the strength, safety, or correctness of methods used, the adequacy of equipment, or from carrying out the work in full compliance with the requirements of the Drawings and as specified herein.

G. Samples

1. The Contractor shall demonstrate to the Engineer on a designated area of the concrete substructure exterior surface that the form release agent will not adversely affect concrete surfaces to be painted, coated, or otherwise finished and will not affect the forming materials.
2. The Contractor shall construct one sample concrete wall 10 feet high by 10 feet long with the architectural forms and the form liner, complete with the form tie pattern and finish as specified. The wall will be viewed by the Engineer in the presence of the Contractor noting specific defects and establishing the quality of the finished architectural concrete for the project. The wall as modified by the Engineer's comments shall serve as the standard against which the acceptability of the actual architectural concrete will be judged. The wall shall remain until all architectural concrete has been placed, finished, and accepted at which time the Contractor shall demolish the wall and remove the debris from the site.

1.04 REFERENCE STANDARDS

A. American Concrete Institute (ACI)

1. ACI 117 – Specifications for Tolerances for Concrete Construction and Materials
2. ACI 301 – Specifications for Concrete Construction
3. ACI 318 – Building Code Requirements for Structural Concrete
4. ACI 347R – Guide to Formwork for Concrete

B. American Plywood Association (APA)

1. APA – Material Grades and Designations as Specified

C. NSF International (NSF)

1. NSF/American National Standards Institute (ANSI) Standard 61 – Drinking Water System Components - Health Effects

D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. The form liner manufacturer's representative shall be on-site during initial installation of the form liner to instruct the Contractor on the proper methods of application and use of the liner. S/He shall be available to answer any questions on the liner that the Engineer may have.

1.06 SYSTEM DESCRIPTION

A. General – Architectural Concrete is wall, slab, beam, or column concrete that will have surfaces exposed to view in the finished work. It includes similar exposed surfaces in water containment structures from the top of the walls to 2 feet below the normal water surface in open tanks and basins.

B. Structural Design Responsibility – All forms and shoring shall be designed at the Contractor's expense by a Professional Civil or Structural Engineer, registered in the

State of California. Formwork shall be designed and erected in accordance with the requirements of ACI 301 and ACI 318 and as recommended in ACI 347 and shall comply with all applicable regulations and codes. The design shall consider any special requirements due to the use of plasticized and/or retarded set concrete.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configurations desired.

2.02 MATERIALS

- A. Forms for cast-in-place concrete shall be made of wood, metal, or other approved material. Wood forms for the project shall be new and unused. Construct wood forms of sound lumber or plywood of suitable dimensions and free from knotholes and loose knots. Where used for exposed surfaces, dress and match boards. Sand plywood smooth and fit adjacent panels with tight joints. Metal forms may be used when approved by the Engineer and shall be of an appropriate type for the class of work involved. All forms shall be designed and constructed to provide a flat, uniform concrete surface requiring minimal finishing or repairs.
- B. Wall Forms:
 - 1. Forms for all exposed exterior and interior concrete walls shall be new and unused "Plyform" exterior grade plywood panels manufactured in compliance with APA and bearing the trademark of that group, or equal acceptable to the Engineer. Provide B grade or better veneer on all faces to be placed against concrete during forming. The class of material and grades of interior plies shall be of sufficient strength and stiffness to provide a flat, uniform concrete surface requiring minimal finishing and grinding.
 - 2. All joints or gaps in forms shall be taped, gasketed, plugged, and/or caulked with an approved material so that the joint will remain watertight and will withstand placing pressures without bulging outward or creating surface patterns.
- C. Column Forms:
 - 1. Rectangular columns shall be formed as specified for wall forms. All corners shall have a 3/4-inch chamfer unless otherwise noted on the Drawings.
 - 2. Circular columns shall be formed with steel, fiberglass-reinforced plastic, or seamless cardboard column forms. The forms shall be continuous for the height of the column between construction joints indicated on the Drawings unless otherwise approved by the Engineer.
- D. Rustications shall be at the location and shall conform to the details shown on the Drawings. Moldings for chamfers and rustications shall be milled and planed smooth. Rustications and corner strips shall be of a nonabsorbent material, compatible with the form surface and fully sealed on all sides to prohibit the loss of paste or water between the two surfaces.
- E. Form Release Agent – Coat all forming surfaces in contact with concrete using an effective, non-staining, non-residual, water-based, bond-breaking form coating, unless otherwise noted. Form release agents used in potable water containment structures shall be suitable for use in contact with potable water and shall be nontoxic and free of taste or odor.
- F. Concrete surfaces that are to be painted shall be formed with hard plastic finished plywood or a similar material that does not require a form release agent unless the

Contractor can substantiate to the satisfaction of the Engineer that the form release agent will not remain on the formed surface after it is stripped.

- G. Forms for Architectural Concrete or Concrete Receiving Architectural Finish:
1. Forms for architectural concrete shall be constructed of materials and in a manner that will result in rigid forms with sufficient strength to withstand, without noticeable deflection, movement, or leakage, the high hydraulic pressures resulting from rapid filling of the forms and heavy, high-frequency vibration of the concrete. Deflection in formwork shall be limited to 1/360 of each component span. Form joints shall be laid out in a uniform pattern or as indicated on the Drawings.
- H. Form Ties:
1. Form ties encased in concrete other than those specified in the following paragraphs shall be designed so that, after removal of the projecting part, no metal shall remain within 1-1/2 inches of the face of the concrete. The part of the tie to be removed shall be at least 1/2 inch in diameter or be provided with a wood or metal cone at least 1/2 inch in diameter and 1-1/2 inches long. Form ties in concrete exposed to view shall be the cone-washer type.
 2. Form ties for exposed exterior and interior walls shall be as specified in the preceding paragraph except that the cones shall be approved wood or plastic.
 3. Flat bar ties for panel forms shall have plastic or rubber inserts having a minimum depth of 1-1/2 inches and sufficient dimensions to permit proper patching of the tie-hole.
 4. Ties for liquid containment structures shall have a neoprene washer at the center of the tie. Snap-Ties shall be Meadow Burke, Tampa, FL; Gates Inc., Denver, CO; or equal.
 5. Common wire shall not be used for form ties.
 6. Alternate form ties, consisting of tapered through-bolts at least 1 inch in diameter at the smallest end or through-bolts that utilize a removable tapered sleeve of the same minimum size, may be used at the Contractor's option. Obtain Engineer's acceptance of system and spacing of ties before ordering or purchasing of forming. Clean, fill, and seal form tie hole with non-shrink cement grout. The Contractor shall be responsible for watertightness of the form ties and any repairs needed.
- I. Void Forms Under Slabs or Grade Beams:
1. Void forms used directly below grade beams and structural slabs shall be preformed cardboard having sufficient strength to support the weight of the reinforcement and the wet concrete placed directly above or adjacent to it without deflecting the void form more than 1/2 inch. Manufacturers include Sure Void Under Slab Void, SureVoid, Denver, CO; VoidForm, VoidForm International, Englewood, CO; or equal.

PART 3 - EXECUTION

3.01 GENERAL

- A. Forms shall be used for all cast-in-place concrete including sides of footings, unless otherwise noted. Forms shall be constructed and placed so that the resulting concrete will be of the shape, lines, dimensions, and appearance indicated on the Drawings.
1. Concrete for elements such as concrete keys, sump slabs, retaining wall footings, pipe encasements and/or pump can encasements may be cast against

earth when approved in writing by the Engineer. If approved, the excavation shall include an additional inch on all sides to account for surface irregularity and concrete cover requirements for the reinforcing steel.

- B. Forms for walls shall have removable panels at the bottom for cleaning, inspection, and joint surface preparation. Forms for wall heights in excess of 16 feet shall have closable intermediate inspection ports. Tremies and hoppers for placing concrete shall be used to allow concrete inspection, prevent segregation, and prevent the accumulation of hardened concrete on the forms above the fresh concrete.
- C. Molding, bevels, or other types of chamfer strips shall be placed to produce blockouts or chamfers as shown on the Drawings or as specified herein. Chamfer strips shall be provided at horizontal and vertical projecting corners to produce a 3/4-inch chamfer. Rectangular or trapezoidal moldings shall be placed in locations requiring sealants where specified or shown on the Drawings. Size of moldings shall conform to the sealant manufacturer's recommendations.
- D. Forms shall be sufficiently rigid to withstand construction loads and vibration and to prevent displacement or sagging between supports. Construct forms such that the concrete and/or exposed rebar (dowels) will not be damaged by their removal. The Contractor shall be entirely responsible for the adequacy of the forming system.
- E. Before form material is reused, all surfaces to be in contact with concrete shall be thoroughly cleaned, all damaged places repaired, all projecting nails withdrawn, and all protrusions smoothed. Reuse of wooden forms for other than rough finish will be permitted only if a "like-new" condition of the form is maintained.
- F. Metal items, such as rebar, wire, or plates used to support pipe penetrations and pipe embedment shall have a minimum clearance of 2 inches from reinforcing bars.
- G. Tolerances in concrete construction shall be in accordance with ACI 117, unless otherwise noted.

3.02 FORM TOLERANCE

- A. Forms shall be surfaced, designed, and constructed in accordance with the recommendations of ACI 347 and shall meet the following additional requirements for specified finishes.
- B. Formed Surfaces Exposed to View – Edges of all form panels in contact with concrete shall be flush within 1/32 inch and forms for plane surfaces shall be such that the concrete will be plane within 1/16 inch in 4 feet. Forms shall be tight to prevent the passage of mortar, water, and grout. The maximum deviation of the finish wall surface at any point shall not exceed 1/4 inch from the intended surface as shown on the Drawings. Form panels shall be arranged symmetrically and in an orderly manner to minimize the number of seams.
- C. Formed surfaces not exposed to view or buried shall meet the requirements of Class "C" Surface in ACI 347.
- D. Formed rough surfaces including mass concrete, pipe encasement, electrical duct encasement, and other similar installations shall have no minimum requirements for surface smoothness and surface deflections. The overall dimensions of the concrete shall be plus or minus 1 inch.
- E. Architectural Concrete – All smooth faces to be exposed to view shall have surface deflections limited to 1/32 inch at any point and the variation in wall deflection shall not exceed 1/16 inch per 4 feet. The maximum deviation of the finished wall surface at any point shall not exceed 1/4 inch from the intended surface as shown on the Drawings. All textured faces, form lines, or rustications to be exposed to view shall be straight, plumb and true with a variation of no more than 1/4 inch in 10 feet measured in any direction.

3.03 FORM PREPARATION

- A. Wood forms in contact with concrete shall be coated with an effective form release agent before form installation.
- B. Steel forms shall be thoroughly cleaned, and mill scale and other ferrous deposits shall be sandblasted or otherwise removed from the contact surface for all forms except those utilized for surfaces receiving a rough finish. All forms shall have the contact surfaces coated with a form release agent.

3.04 REMOVAL OF FORMS

- A. The Contractor shall be responsible for all damage resulting from removal of forms. Form removal shall conform to the requirements specified in Section 03 30 00.

3.05 INSPECTION

- A. The Engineer shall be notified when the forms are complete and ready for inspection at least 24 hours before the proposed concrete placement.
- B. Concrete shall not be poured until reinforcement placement has been inspected per specification 03 31 00.
- C. Failure of the forms to comply with the requirements specified herein, or to produce concrete complying with the requirements of this Section, in the opinion of the Engineer, shall be grounds for rejection of that portion of the form/concrete work. Rejected work shall be repaired or replaced as directed by the Engineer at no additional cost to the District. Such repair or replacement shall be subject to the requirements of this Section and approval of the Engineer.

3.06 FALSEWORK

- A. The Contractor shall be responsible for the design, engineering, construction, maintenance, and safety of all falsework, including staging, walkways, forms, ladders, and similar appurtenances, which shall equal or exceed the applicable requirements of the provisions of the OSHA Safety and Health Standards for Construction, the requirements of the Construction Safety Orders of the California Division of Industrial Safety, and the requirements specified herein.
- B. All falsework shall be designed and constructed to provide the necessary rigidity and to support the loads. Falsework for the support of a superstructure shall be designed to support the loads that would be imposed if the entire superstructure were placed at one time.
- C. Falsework shall be placed upon a solid footing, safe against undermining, and protected from softening. When the falsework is supported on timber piles, the maximum calculated pile loading shall not exceed 20 tons. When falsework is supported on any portion of the structure that is already constructed, the loading imposed by the falsework shall be spread, distributed, and braced in such a way as to avoid any possibility of damage to the structure.

END OF SECTION

SECTION 03 15 00

CONCRETE JOINTS AND ACCESSORIES

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required and install accessories for concrete joints as shown on the Drawings and as specified herein.

1.02 RELATED SECTIONS

- A. Section 03 10 00 – Concrete Forms and Accessories
- B. Section 03 21 00 – Concrete Reinforcement
- C. Section 03 30 00 – Cast-in-Place Concrete
- D. Section 03 35 00 – Concrete Finishing
- E. Section 03 60 00 – Grouts
- F. Section 03 92 20 – Modifications and Repairs to Concrete
- G. Section 05 50 00 – Metal Fabrications
- H. Section 07 90 00 – Joint Sealing, except sealant for water retaining concrete structure joints is covered in this Section.

1.03 SUBMITTALS

- A. Submit to the Engineer, in accordance with Division 1, submittals including the following below.
 - 1. Waterstops – Product data including catalogue cut, technical data, storage requirements, splicing methods, and conformity to ASTM standards.
 - 2. Premolded Joint Fillers – Product data including catalogue cut, technical data, storage requirements, installation requirements, location of use, and conformity to ASTM standards.
 - 3. Bond Breaker – Product data including catalogue cut, technical data, storage requirements, installation requirements, location of use, and conformity to ASTM standards.
 - 4. Expansion Joint Dowels – Product data on the complete assembly including dowels, coatings, lubricants, spacers, sleeves, expansion caps, installation requirements, and conformity to ASTM standards.
 - 5. Compressible Joint Filler – Product data including catalogue cut, technical data, storage requirements, installation requirements, location of use, and conformity to ASTM standards.
 - 6. Bonding Agents – Product data including catalogue cut, technical data, storage requirements, product life, application requirements, and conformity to ASTM standards.
 - 7. Sealant – Product data including location of use, catalogue cut, technical data, storage requirements, mixing and application instructions, and conformity to ASTM standards.
 - 8. Samples – Two samples of each type of waterstop fitting(s).

- B. Certifications:
1. Certify that all materials used within the joint system are compatible with each other.
 2. Certify that waterstops used in water bearing structures are NSF International/American National Standards Institute (NSF/ANSI) Standard 61 compliant, with certification from an independent ANSI/Environmental Laboratory Accreditation Program (ANSI/ELAP)-accredited testing laboratory acceptable to the Engineer but engaged by and at the expense of the Contractor.
 3. Certify that sealant is made for use in continuous immersion in contact with potable water and is certified by NSF/ANSI Standard 61.
 4. Certify that sealant for the Ozone Contactor is made for use in continuous immersion in contact with potable water having ozone at a concentration of 3.0 milligrams per liter and for continuous exposure to air having ozone at a concentration of 1 percent by weight and is certified by NSF/ANSI Standard 61.

1.04 REFERENCE STANDARDS

- A. Federal Specifications
1. SS-S-210A – Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints
- B. ASTM International (ASTM)
1. ASTM A675 – Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties
 2. ASTM C881 – Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
 3. ASTM C1059 – Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete
 4. ASTM D471 – Standard Test Method for Rubber Property-Effect of Liquids
 5. ASTM D1751 – Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
 6. ASTM D1752 – Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
- C. NSF International (NSF)
1. NSF/ANSI Standard 61 – Drinking Water System Components - Health Effects
- D. US Army Corps of Engineers (CRD)
1. CRD-C 572 – Specification for Polyvinylchloride Waterstops
- E. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

- B. All materials used together in a given joint (bond breakers, backer rods, joint fillers, sealants, etc.) shall be compatible with one another. Coordinate selection of suppliers and products to ensure compatibility. Under no circumstances shall asphaltic bond breakers or joint fillers be used in joints receiving sealant.
- C. All chemical sealant type waterstops shall be products specifically manufactured for the purpose for which they will be used, and the products shall have been successfully used on similar structures for more than five years.

2.02 MATERIALS

- A. Polyvinylchloride (PVC) Waterstops (Standard) - The PVC waterstops shall be made by extruding elastomeric plastic compound with virgin PVC as the basic resins. The compound shall contain no reprocessed materials. Minimum tensile strength of waterstops shall be 1,750 pounds per square inch. The waterstops shall conform to CRD-C 572. Provide shop-fabricated waterstop fittings for all intersections. Only straight butt joint splices may be made in the field.
 - 1. Waterstops for expansion joints shall be 9 inches wide and be ribbed type with a center bulb. Expansion joint waterstops shall be style 738 by Greenstreak Corporation; style RB938H by Vinylex Corporation; or equal.
 - 2. Waterstops for non-expansion joints shall be 6 inches wide and be the flat ribbed type. Non-expansion joint waterstops shall be style 679 by Greenstreak Incorporated; style R638 by Vinylex Corp.; or equal. Equal waterstops may have an integral fastening system
- B. Thermoplastic Elastomeric Rubber (TPER) Waterstops for Construction Joints at Chemical Containment Structures - Provide 6-inch or 9-inch ribbed centerbulb type TPER waterstops as indicated on the Drawings. The waterstops shall conform to ASTM D471. Provide shop-fabricated waterstop fittings for all intersections. Only straight butt joint splices may be made in the field. Waterstops shall be JP636 and JP936 by JP Specialties, Inc.; Style 619 and Style 620 by Westec Barrier Technologies; or equal. Where L-shaped TPER retrofit waterstop is called for on the Drawings, the waterstop shall have 3-inch long legs and shall have similar material properties to the standard TPER waterstops defined above.
- C. Retrofit Waterstop - A 3-inch T-shaped retrofit waterstop shall be provided as indicated on the Drawings. The waterstop shall conform to ASTM D471. Provide shop-fabricated waterstop fittings for all intersections. Only straight butt joint splices may be made in the field. The retrofit waterstop system shall include all necessary stainless-steel bars and bolts and epoxy bonding agent. The waterstop shall be JP325T by JP Specialties, Inc.; Style 629 by Westec Barrier Technologies; or equal.
- D. Expansive Waterstops for construction joints where shown on the Drawings: Preformed hydrophilic rubber strips. Installation adhesives used with the expansive waterstops shall be as recommended by the waterstop manufacturer. The waterstop shall be Adeka Ultraseal MC-2010MN as distributed by Mitsubishi of Houston, TX; Hydrotite CJ-1020-2K by Greenstreak Plastic Products, St. Louis, MO, or equal.
- E. Preformed Adhesive Waterstops - Provide preformed adhesive waterstops at construction joints between existing concrete or concrete pipe and cast in place concrete. The waterstops shall be rope type, preformed plastic waterstops meeting the requirements of Federal Specification SS-S-210A. The rope shall have a cross section of approximately 1 square inch unless otherwise specified or shown on the Drawings. The waterstops shall be Synko-Flex Waterstop as manufactured by Synko-Flex Products or equal. Primer for the material shall be as recommended by the waterstop manufacturer.
- F. Premolded Joint Filler:

1. Premolded joint filler for structures shall be self-expanding cork, premolded joint filler conforming to ASTM D1752, Type III. The thickness shall be 3/4 inch unless shown otherwise on the Drawings.
 2. Premolded joint filler for sidewalk and roadway concrete pavements, or where fiber joint filler is specifically noted on the Drawings, shall be asphalt-impregnated fiberboard conforming to ASTM D1751. The thickness shall be 3/4 inch unless otherwise shown on the Drawings.
- G. Bond Breaker:
1. Bond breaker tape shall be an adhesive-backed, glazed butyl or polyethylene tape that will satisfactorily adhere to the premolded joint filler or concrete surface as required. The tape shall be the same width as the joint.
 2. Except where tape is specifically called for on the Drawings, bond breaker for concrete shall be either bond breaker tape or a non-staining type bond prevention coating such as Silcoseal Select, by Nox-Crete; Conlift Bondbreaker Waterbased, by Parchem, or equal.
- H. Expansion Joint Dowels:
1. Dowels shall be smooth steel conforming to ASTM A675, Grade 70. Dowels must be straight and clean, free of loose, flaky rust and loose scale. Dowels may be sheared to length provided deformation from true shape caused by shearing does not exceed 0.04 inch on the diameter of the dowel and extends no more than 0.04 inch from the end. Bars shall be coated with a bond breaker on the expansion end of the dowel. Expansion caps shall be provided on the expansion end.
 2. Expansion dowel caps shall be No. 87 dowel caps as manufactured by Heckmann Building Products, Inc.; K11 Dowel Caps, by Dayton Superior; or equal.
- I. Bonding Agent:
1. Epoxy bonding agent shall be two-component, solvent-free, moisture insensitive, epoxy resin material conforming to ASTM C881, Type II for non-load-bearing applications and Type V for load-bearing applications. The bonding agent shall be Sikadur 32 Hi-Mod by Sika Corporation; Concsive Liquid LPL by BASF Building Systems; or equal.
 2. Latex bonding agent shall be non-reemulsifiable acrylic-polymer latex conforming to ASTM C1059, Type II.
- J. Compressible Joint Filler:
1. The joint filler shall be a non-extruded, watertight strip material used to fill expansion joints between structures. The material shall be capable of being compressed at least 40 percent for 70 hours at 68 degrees Fahrenheit and subsequently recovering at least 20 percent of its original thickness in the first 1/2 hour after unloading. Compressible joint filler shall be Phyzite®/Evazote 380 as manufactured by Chase Construction Products; Wabo®/Evazote UV as manufactured by BASF Chemical Company; or equal.
- K. Water Retaining Structure Sealant
1. Sealant for water retaining structures shall be a multi-part polyurethane sealant. Provide sealant for joints in horizontal surfaces conforming to ASTM C920, Type S or M, Grade P or NS, Class 25. Provide sealant for joints in sloping and vertical surfaces conforming to ASTM C920, Type S or M, Grade NS, Class 25.

2. Provide sealants made for use in continuous immersion in contact with potable water and certified by NSF/ANSI Standard 61. Provide gray colored sealants unless otherwise indicated on the Drawings, specified, or approved.
 3. Sealant shall be Sikaflex-2c by Sika Corporation; PSI-270 by Polymeric Systems, Inc.; or equal.
- L. Hydrophilic Waterstop Caulking:
1. Hydrophilic waterstop caulking shall be a single component, water-swelling sealant. Hydrophilic waterstop caulking shall be Adeka P-201 by Adeka Corporation; Leakmaster LV-1 by Greenstreak Corporation; or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Standard Waterstop:
1. Install waterstops for all joints where indicated on the Drawings. Waterstops shall be continuous around all corners and intersections so that a continuous seal is provided. All fittings shall be factory made or shop welded in accordance with manufacturer's recommendations. Only straight butt splices shall be fabricated in the field.
 2. PVC and TPER splices shall be made by welding in accordance with the manufacturer's recommendations, subject to acceptance of the Engineer. Waterstop intersection fittings shall be shop-fabricated. Only straight butt joint splices may be made in the field. Only manufacturer's special approved tools shall be used for welding. The finished splices shall provide a cross section that is dense and free of porosity.
 3. To properly secure PVC and TPER waterstops in wall joints before concrete is placed, center the waterstop in the joint. Clamp both edges of the waterstop and fasten to reinforcing steel with black annealed steel tie wire as specified for tying reinforcing steel and secure in place so that the waterstop will be perpendicular to the joint and will remain in the required position during concrete placement. The spacing of the waterstop ties shall match the spacing of the adjacent reinforcing but need not be spaced closer than 12 inches on-center. Secure waterstops in joints before concrete is placed. Horizontal waterstops in slabs shall be clamped in position by the bulkhead (unless previously set in concrete).
 4. Horizontal PVC waterstops in slabs shall have the edge of the waterstop lifted while placing concrete below the waterstop. The waterstop shall then be manually forced against and into the placed concrete and covered with fresh concrete, to ensure adequate encasement of the waterstop in concrete.
 5. Each piece of the waterstop shall be of maximum practicable length to provide a minimum number of splices.
 6. Waterstops shall be installed so that half of the width will be embedded on each side of the joint. Care shall be exercised to ensure that the waterstop is completely embedded in void-free concrete.
 7. Waterstops shall be terminated 3 inches below the exposed top of walls.
- B. Expansive Waterstops
1. Prepare the joint surfaces, install primers or adhesives, and install expansive waterstops in accordance with the manufacturer's instructions.
- C. Construction Joints (CJ):

1. Make construction joints only at locations shown on the Drawings or as approved by the Engineer. Any additional or relocation of construction joints proposed by the Contractor must be submitted to the Engineer for written approval.
 2. All joints shall be perpendicular to main reinforcement. Continue reinforcing steel through the joint as indicated on the Drawings.
 3. Provide sealant grooves for joint sealant where indicated on the Drawings.
 4. At all construction joints (water and non-water containment), and at concrete joints designated on the Drawings to be "roughened," uniformly roughen the surface of the concrete to full amplitude (distance between high and low points or side to side) of approximately 1/4 inch to expose a fresh face. Thoroughly clean joint surfaces of loose or weakened materials by water blasting or sandblasting and prepare for bonding. At least 2 hours before, and again shortly before the new concrete is deposited, saturate the joints and adjacent concrete surfaces to at least 12 inches past the joint with water.
 5. At horizontal construction joints for water containment structures, Contractor shall deposit 1/2" to 2" of mortar containing the same proportions of cement, sand, and water as used in the approved mix into the forms. Mortar shall be placed immediately before depositing the concrete and shall be plastic (neither stiff nor fluid) when the concrete is placed.
 6. In lieu of the above method for bonding plastic concrete to hardened concrete, the following optional method may be used. Concrete must be allowed to set a minimum of 28 days. Use a latex-bonding agent applied to roughened and cleaned surfaces of set concrete in strict accordance with manufacturer's recommendations.
 7. Provide waterstops in all wall and slab construction joints in liquid containment structures and at other locations shown on the Drawings.
 8. Keyways shall not be used in construction joints unless specifically shown on the Drawings or approved by the Engineer.
- D. Partial Contraction Joints (PCJ):
1. Provide sealant grooves, sealants, and waterstops at partial contraction joints in slabs on grade or walls as detailed. Provide waterstops at all wall and slab partial contraction joints in water containment structures and at other locations shown on the Drawings.
 2. Partial contraction joints may be sawed if specifically approved by the Engineer. If partial contraction joint grooves are sawed, properly time the saw cutting with the time of the concrete set. Start cutting as soon as concrete has hardened sufficiently to prevent aggregates from being dislodged by the saw. Complete cutting before shrinkage stresses have developed sufficiently to induce cracking. No reinforcing shall be cut during sawcutting.
 3. Extend every other bar of reinforcing steel through partial contraction joints or as indicated on the Drawings. Where specifically noted on the Drawings, coat the concrete surface of the joint with a bond breaker before placing new concrete against the joint. Avoid coating reinforcement or waterstops with bond breaker at these locations.
- E. Expansion Joints (EJ):
1. Do not extend through expansion joints, reinforcement, or other embedded metal items that are continuously bonded to concrete on each side of the joint.
 2. Position premolded joint filler material accurately. Secure the joint filler against displacement during concrete placement and compaction. Place joint filler over

the face of the joint, allowing for sealant grooves as detailed on the Drawings. Tape all joint filler splices to prevent intrusion of mortar. Seal expansion joints as shown on the Drawings.

3. Expansion joints shall be 3/4 inch in thickness unless otherwise noted on the Drawings.

F. Water Retaining Structure Sealant

1. Install sealant in clean dry recesses free of frost, oil, grease, form release agent, loose material, laitance, dirt, dust, and other materials which will impair bond at the locations shown on the Drawings. Apply sealant conforming to the manufacturer's recommendations including concrete cure, temperature, moisture, mixing, primer, primer cure time, joint and recess preparation, tooling, and curing. Apply masking tape to each side of the joint prior to the installation of the sealant and remove afterwards along with any spillage to leave a sealant installation with neat straight edges.

END OF SECTION

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SECTION 03 21 00

CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install all concrete reinforcement complete as shown on the Drawings and as specified herein.

1.02 RELATED SECTIONS

- A. Section 03 10 00 – Concrete Forms and Accessories
- B. Section 03 15 00 – Concrete Joints and Accessories
- C. Section 03 30 00 – Cast-in-Place Concrete
- D. Section 03 36 00 – Electrical and Instrumentation Duct Encasement Concrete
- E. Section 03 60 00 – Grouts
- F. Section 03 92 20 – Modifications and Repairs to Concrete

1.03 SUBMITTALS

- A. Reinforcing Steel - Submit to the Engineer, in accordance with Division 1, placement drawings conforming to the recommendations of ACI 315. All reinforcement in a concrete placement shall be included in a single placement drawing or cross-referenced to the pertinent main placement drawing. The main drawing shall include the additional reinforcement (around openings, at corners, etc.) shown on the standard detail sheets. Bars to have special coatings and/or to be of special steel or special yield strength are to be clearly identified.
 - 1. Indicate locations of anchors, if used.
 - 2. Indicate locations of pipe/conduit penetrations.
 - 3. Indicate locations, types, and materials of the proposed bar supports.
- B. Bar Bending Details – The bars shall be referenced to the same identification marks shown on the placement drawings. Bars to have special coatings and/or to be of special steel or special yield strength shall be clearly identified.
- C. Mechanical Connectors – Submit two samples of each type of mechanical reinforcing steel connectors.
- D. Test Reports – Submit test reports for each of the following items:
 - 1. Mill Test – Submit a certified copy of mill test on each steel proposed for use showing the physical properties of the steel and the chemical analysis.
 - 2. Foreign Manufactured Steel – Submit a certified copy of test reports for each foreign manufactured steel proposed for use in the fabrication of reinforcement. The tests shall be specifically made for this project at the expense of the Contractor by a domestic independent testing laboratory certified to perform the tests. The testing shall be for conformity to the applicable ASTM standard(s).
 - 3. Beam Cages – Submit a certified copy of weld test report(s) for beam cages fabricated by means of the Schnell IDEA Machine.
 - 4. Welder – Welder certification shall be in accordance with AWS D1.4 when welding of reinforcement is required.

1.04 REFERENCE STANDARDS

- A. Federal Specifications
 - 1. QQ-W-461H – Wire, Steel, and Carbon (round, bare and coated)
- B. American Concrete Institute (ACI)
 - 1. ACI 301 – Specifications for Structural Concrete
 - 2. ACI 318 – Building Code Requirements for Structural Concrete
 - 3. ACI SP-66 – ACI Detailing Manual
- C. ASTM International (ASTM)
 - 1. ASTM A615 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
 - 2. ASTM A706 – Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement
 - 3. ASTM A1064 – Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
 - 4. ASTM C1116 – Standard Specification for Fiber-Reinforced Concrete
- D. American Welding Society (AWS)
 - 1. AWS D1.4 – Structural Welding Code - Reinforcing Steel
- E. Concrete Reinforcing Steel Institute (CRSI)
 - 1. CRSI – Manual of Standard Practice
- F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A. In no case shall any reinforcing steel be covered with concrete until the installation of the reinforcement, including the size, spacing, and position of the reinforcement has been observed by the Engineer and the Engineer's release to proceed with concreting has been obtained. The Engineer shall be given ample prior notice of the readiness of placed reinforcement for observation. The forms shall be kept open until the Engineer has completed observations of the reinforcing steel.

1.06 DELIVERY, HANDLING, AND STORAGE

- A. Reinforcing steel shall be substantially free from mill scale, rust, dirt, grease, or other foreign matter.
- B. Reinforcing steel shall be shipped and stored with bars of the same size and shape, fastened in bundles with durable tags, marked in a legible manner with waterproof markings showing the same "mark" designations as those shown on the submitted placement drawings.
- C. Reinforcing steel shall be stored off the ground, protected from moisture, and kept free from dirt, oil, or other injurious contaminants.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configurations desired.

2.02 MATERIALS

- A. Materials shall be new and shall comply with the following material specifications.
- B. Deformed Concrete Reinforcing Bars shall be ASTM A615 or ASTM A706, Grade 60 deformed bars.
- C. Concrete reinforcing bars required on the Drawings are to be field bent or welded ASTM A706, Grade 60 deformed bars.
- D. Spiral Reinforcement shall comply with the following:
 - 1. ASTM A615, Grade 60 for hot-rolled plain or deformed bars
 - 2. ASTM A82 for cold-drawn wire
- E. Welded Steel Wire Fabric shall comply with ASTM A185.
- F. The following alternative materials are allowed:
 - 1. ASTM A615, Grade 60 may be used for ASTM A706 provided the following requirements are satisfied:
 - a. The actual yield strength of the reinforcing steel based on mill tests shall not exceed the specified yield strength by more than 18,000 pounds per square inch (psi). Retests shall not exceed this value by more than an additional 3,000 psi.
 - b. The ratio of the actual ultimate tensile strength to the actual tensile yield strength of the reinforcement shall not be less than 1.25.
 - c. The carbon equivalency (CE) of the bars shall be 0.55 or less.
- G. Reinforcing Steel Accessories:
 - 1. Plastic protected bar supports shall comply with CRSI Bar Support Specifications, Class 1 - Maximum Protection.
 - 2. Stainless steel protected bar supports shall comply with CRSI Bar Support Specifications, Class 2 - Moderate Protection.
 - 3. Precast concrete block bar supports (dobies) shall comply with CRSI Bar Support Specifications, Precast Block. Block shall have equal or greater compressive strength than the surrounding concrete.
- H. Tie Wire:
 - 1. Tie Wires for Reinforcement shall be 16-gauge or heavier, black annealed wire, conforming to Federal Specification QQ-W-461H.
- I. Mechanical reinforcing steel butt splices shall be positive connecting taper-threaded type employing a hexagonal coupler such as Lenton rebar splices as manufactured by Erico Products, Inc.; Grip-Twist as manufactured by BarSplice Products, Inc.; or equal. They shall meet all ACI 318 Building Code requirements. Bar ends must be taper-threaded with coupler manufacturer's bar threader to ensure proper taper and thread engagement. Bar couplers shall be torqued to manufacturer's recommended value.
 - 1. Unless otherwise noted on the Drawings, mechanical tension splices shall be designed to produce splice strength in tension or compression of not less than 125 percent of the ASTM-specified minimum yield strength of the rebar.
 - 2. Compression type mechanical splices shall provide concentric bearing from one bar to the other and shall be capable of developing the ultimate strength of the rebar in compression.
- J. Fibrous Reinforcement - The fibers shall be 100 percent virgin homopolymer polypropylene fibrillated fibers, containing no reprocessed olefin materials, manufactured

in accordance with applicable building codes and ASTM C1116 Type III. Fibrous concrete reinforcement shall be Fibermesh 300, as manufactured by Propex Concrete Systems Corporation; Durafiber, as manufactured by Durafiber, Inc.; or equal.

1. Acceptable polypropylene fibers shall possess the following characteristics:
 - a. Specific Gravity: 0.91 ± 1
 - b. Tensile Strength: 80–110 ksi (kips per square inch)
 - c. Fiber Length: Graded per manufacturer.

2.03 FABRICATION

- A. Fabrication of reinforcement shall be in compliance with the CRSI Manual of Standard Practice.
- B. Bars shall be cold bent. Bars shall not be straightened or re-bent.
- C. Bars shall be bent around a revolving collar having a diameter of not less than that recommended by ACI 318.
- D. Bar ends that are to be butt-spliced, placed through limited diameter holes in metal, or threaded shall have the applicable end(s) saw-cut. Such ends shall terminate in flat surfaces within 1.5 degrees of a right angle to the axis of the bar.
- E. Spirals:
 1. Provide a minimum of one and one-half finishing turns at top and bottom, unless otherwise noted.
 2. Splices shall be tension lap splices at least 48 bar diameters, but not less than 12 inches in length. Welded splices shall only be used where specifically approved by the Engineer.
 3. Provide spacers as recommended by CRSI.
- F. Schnell IDEA Machine – Contractor may fabricate rebar cages for beams using the Schnell IDEA Machine, with the following provisions:
 1. Fabrication of pre-assembled steel cages shall be in a shop of a fabricator licensed to use the Schnell IDEA Machine and with an in-house quality assurance program.
 2. Shipping of pre-assembled steel cages to the project site will include a copy of the rebar certificate from the mill and a copy of the welding test report from an approved third-party test lab, engaged by and at the expense of the Contractor. The welding test is for the purpose of providing assurances that the rebar was not damaged during welding operations.
 3. Rebar to be welded shall comply with ASTM A706, Grade 60.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Surface condition, bending, spacing, and tolerances of placement of reinforcement shall comply with CRSI Manual of Standard Practice. The Contractor shall be solely responsible for providing an adequate number of bars and maintaining the spacing and clearances shown on the Drawings.
- B. Except as otherwise noted on the Drawings, the minimum concrete cover for reinforcement shall be as follows:
 1. Concrete cast against and permanently exposed to earth: 3 inches

2. Concrete exposed to soil, water, sludge, and/or weather (including bottom cover of slabs over water): 2 inches
 3. Concrete not exposed to soil, water, sludge, and/or weather:
 - a. Slabs (top and bottom cover), walls, joists, shells, and folded plate members: 1.5 inches
 - b. Beams and columns, primary reinforcement: 2 inches
 - c. Ties, spirals, and stirrups: 1.5 inches
- C. Tie wires for all concrete shall have 1.5 inches minimum concrete cover.
- D. Reinforcement that will be exposed for a considerable length of time after being placed shall be coated with a heavy coat of neat cement slurry.
1. Remove cement slurry from reinforcement by wire brushing or sandblasting prior to placement of the subsequent concrete.
- E. No reinforcing steel bars shall be welded either during fabrication or erection unless specifically shown on the Drawings or specified herein, or unless prior written approval has been obtained from the Engineer. All bars that have been welded, including tack welds, without such approval shall be immediately removed from the work and replaced at the expense of the Contractor. If welding of reinforcement is approved or specifically called for, it shall comply with AWS D1.4.
- F. Reinforcing steel interfering with the location of other reinforcing steel, conduits, or embedded items may be moved within the specified tolerances or one bar diameter, whichever is greater. Greater displacements of bars to avoid interference shall only be made with the approval of the Engineer. Do not cut reinforcement to install inserts, conduits, mechanical openings, or other items without the prior approval of the Engineer.
- G. Securely support and tie reinforcing steel to prevent movement during concrete placement. Secure dowels in place before placing concrete.
- H. Wall reinforcing steel bars shall be individually tied in place. Wall reinforcing cages shall not be pre-assembled and "flown" into place.
- I. Reinforcing steel bars shall not be field bent except where shown on the Drawings or specifically authorized in writing by the Engineer. If authorized, bars shall be cold-bent around a standard diameter spool as specified within CRSI. Do not heat bars. Closely inspect the reinforcing steel for breaks. If the reinforcing steel is damaged, replace, Cadweld, or otherwise repair as directed by the Engineer. Do not bend reinforcement after it is embedded in concrete unless specifically permitted on the Drawings.

3.02 REINFORCEMENT AROUND OPENINGS

- A. Unless specific additional reinforcement around openings is shown on the Drawings, provide additional reinforcing steel on each side of the opening equivalent to one-half of the cross-sectional area of the reinforcing steel interrupted by the opening. The bars shall have sufficient length to develop bond at each end beyond the opening or penetration.

3.03 SPLICING OF REINFORCEMENT

- A. Splices designated as compression splices on the Drawings shall be 30 bar diameters, but not less than 12 inches, unless otherwise noted.
- B. Tension lap splices shall be provided at all laps in compliance with ACI 318. The length of splices shall conform to the Drawings. Unless otherwise noted on the Drawings, rebar splices shall be contact lap splices. Splices in adjacent bars shall be staggered. Class A splices may be used when 50 percent or less of the bars are spliced within the required lap length. Class B splices shall be used at all other locations.

- C. Except as otherwise indicated on the Drawings, splices in circumferential reinforcement in circular walls shall be Class B tension splices and shall be staggered. Rebar splices shall be contact lap splices. Adjacent bars shall not be spliced within the required lap length.
- D. Install wire fabric in as long lengths as practicable. Splices in welded wire fabric shall be lapped in accordance with the requirements of ACI 318 but not less than 12 inches. The spliced fabrics shall be tied together with wire ties spaced not more than 24 inches on-center and laced with wire of the same diameter as the welded wire fabric. Do not position laps midway between supporting beams, or directly over beams of continuous structures. Offset splices in adjacent widths to prevent continuous splices.
- E. Mechanical reinforcing steel splicers shall be used only where shown on the Drawings. Splices in adjacent bars shall be offset by at least 30 bar diameters, but not less than 24 inches. Mechanical reinforcing splices are only to be used for special splice and dowel conditions approved by the Engineer.

3.04 ACCESSORIES

- A. Determine, provide, and install accessories such as chairs, chair-bars, and the like in sufficient quantities and strength to adequately support the reinforcement and prevent its displacement during the erection of the reinforcement and the placement of concrete.
- B. Use precast concrete blocks (dobies) where the reinforcing steel is to be supported over soil. In no case shall such supports be continuous.
- C. Stainless steel bar supports or steel chairs with stainless steel tips shall be used where the chairs are set on forms for a concrete surface that will be exposed to weather, high humidity, or liquid (including bottom of slabs over liquid-containing areas). Stainless steel bar supports shall also be used for all water bearing concrete structures. Use of galvanized or plastic-tipped metal chairs is permissible in all other locations unless otherwise noted on the Drawings or specified herein.
- D. Alternate methods of supporting top steel in slabs, such as steel channels supported on the bottom steel or vertical reinforcing steel fasteners to the bottom and top mats may only be used if approved by the Engineer.

3.05 FIELD QUALITY CONTROL

- A. In no case shall any reinforcing steel be covered with concrete until the installation of the reinforcement, including the size, spacing, and position of the reinforcement, has been observed by the Engineer and the Engineer's release to proceed with the concreting has been obtained. The Engineer shall be given a minimum of 48 hours prior notice of the readiness of placed reinforcement for observation. The forms shall be kept open until the Engineer has completed observations of the reinforcing steel.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor and materials required and install all cast-in-place concrete complete as shown on the Drawings and as specified herein.
- B. Furnish all sampling and testing of products and materials by an independent testing laboratory acceptable to the Engineer but engaged by and at the expense of the Contractor.

1.02 RELATED SECTIONS

- A. Section 03 10 00 – Concrete Forms and Accessories
- B. Section 03 15 00 – Concrete Joints and Accessories
- C. Section 03 21 00 – Concrete Reinforcement
- D. Section 03 35 00 – Concrete Finishing
- E. Section 03 36 00 – Electrical and Instrumentation Duct Encasement Concrete
- F. Section 03 60 00 – Grouts
- G. Section 03 92 20 – Modifications and Repairs to Concrete
- H. Moisture Protection is included in Division 7.

1.03 SUBMITTALS

- A. Submit to the Engineer, in accordance with Division 1, submittals including the following:
 - 1. Sources of cement and aggregates.
 - 2. Material Safety Data Sheets (MSDS) for all concrete components and admixtures.
 - 3. Air-entraining admixture - Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations, and conformity to ASTM standards.
 - 4. Water-reducing admixture - Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations, and conformity to ASTM standards.
 - 5. High-range, water-reducing admixture - Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations, retarding effect, slump range and conformity to ASTM standards. Identify proposed locations for use.
 - 6. Concrete mix design for each formulation of concrete proposed for use including constituent quantities per cubic yard, water-cementitious materials ratio, type and manufacturer of cement, compressive strength, concrete slump, shrinkage, and air content. Provide with (a) or (b) below for each mix proposed.
 - a. Standard deviation data for each proposed concrete mix based on statistical records, OR,
 - b. The curve of water-cementitious materials ratio versus concrete cylinder strength for each formulation of concrete proposed based on laboratory

tests. The cylinder strength shall be the average of the 28-day cylinder strength test results for each mix. Provide results of 7- and 14-day tests if available.

7. Sheet curing material. Product data including catalogue cut, technical data, and conformity to ASTM standards.
8. Liquid curing compound – Product data including catalogue cut, technical data, storage requirements, product life, application rate, and conformity to ASTM standards. Identify proposed locations of use.
9. Samples – Fine and coarse aggregates if requested by the Engineer.
10. Test Reports – Submit test reports for each of the following items:
 - a. Fine aggregates – Sieve analysis, physical properties, and deleterious substances.
 - b. Coarse aggregates – Sieve analysis, physical properties, and deleterious substances.
 - c. Cements – Chemical analysis and physical properties for each type.
11. Certifications:
 - a. Certify that concrete constituents for Class D concrete (cement, fine aggregates and coarse aggregates) are NSF International/American National Standards Institute (NSF/ANSI) Standard 61 compliant, with certification from an independent ANSI/Environmental Laboratory Accreditation Program (ANSI/ELAP)-accredited testing laboratory acceptable to the Engineer but engaged by and at the expense of the Contractor.
 - b. Certify that admixtures are NSF/ANSI Standard 61 compliant.
 - c. Certify that curing compounds are NSF/ANSI Standard 61 compliant (nontoxic and free of taste or odor).
 - d. Certify that admixtures used in the same concrete mix are compatible with each other and the aggregates.
 - e. Certify that the Contractor is not associated with the independent testing laboratory nor does the Contractor, or its officers have a beneficial interest in the laboratory.
12. Shrinkage test reports
13. Work Plans:
 - a. Hot weather concreting.
 - b. Cold weather concreting.
14. Field test reports for concrete compressive strength, concrete slump, concrete air content, and concrete shrinkage. Report to the Engineer the on-site test results the same day they are measured. Provide all test reports within 7 days of each test's completion.

1.04 REFERENCE STANDARDS

- A. American Concrete Institute (ACI)
 1. ACI 304R – Guide for Measuring, Mixing, Transporting, and Placing Concrete
 2. ACI 305R – Guide to Hot Weather Concreting
 3. ACI 306R – Guide to Cold Weather Concreting
 4. ACI 318 – Building Code Requirements for Structural Concrete

5. ACI SP-66 – ACI Detailing Manual
- B. ASTM International (ASTM)
1. ASTM C31 – Standard Practice for Making and Curing Concrete Test Specimens in the Field
 2. ASTM C33 – Standard Specification for Concrete Aggregates
 3. ASTM C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
 4. ASTM C42 – Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
 5. ASTM C94 – Standard Specification for Ready-Mixed Concrete
 6. ASTM C143 – Standard Test Method for Slump of Hydraulic Cement Concrete
 7. ASTM C150 – Standard Specification for Portland Cement
 8. ASTM C157 – Standard Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete
 9. ASTM C171 – Standard Specification for Sheet Materials for Curing Concrete
 10. ASTM C173 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
 11. ASTM C231 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
 12. ASTM C260 – Standard Specification for Air-Entraining Admixtures for Concrete
 13. ASTM C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
 14. ASTM C494 – Standard Specification for Chemical Admixtures for Concrete
 15. ASTM C596 – Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement
 16. ASTM C1017 – Standard Specification for Chemical Admixtures for use in Producing Flowing Concrete
- C. NSF International (NSF)
1. NSF/ANSI Standard 61 – Drinking Water System Components - Health Effects
- D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A. Reinforced concrete shall comply with ACI 318, and other stated requirements, codes, and standards. The most stringent requirement of the codes, standards, and this Section shall apply when conflicts arise.
- B. Only one source of cement and aggregate shall be used on any one structure. Concrete shall be uniform in color and appearance.
- C. Well in advance of placing concrete, discuss with the Engineer the sources of individual materials and batched concrete proposed for use. Discuss placement methods, waterstops, and curing. Propose methods of hot and cold weather concreting as required.
- D. A meeting shall be held before the placement of plasticized concrete. The plasticizer (high-range water-reducer) manufacturer's representative and the Contractor shall be

available to discuss the properties and techniques of batching and placing plasticized concrete. Services of the manufacturer's representative shall be at no additional cost to the District.

- E. If, during the progress of the work, it is impossible to secure concrete of the required workability and strength with the materials being furnished, the Engineer may order such changes in proportions or materials, or both, as may be necessary to secure the desired properties. All changes so ordered shall be made at the Contractor's expense.
- F. If, during the progress of work, the materials from the sources originally accepted change in characteristics, the Contractor shall, at their expense, make new acceptance tests of aggregates and establish new design mixes.
- G. Testing of the following materials by an independent testing laboratory, acceptable to the Engineer, shall be engaged by and at the expense of the Contractor to verify conformity with this Specification Section and the stated ASTM Standard(s).
 - 1. Fine aggregates for conformity to ASTM C33 – sieve analysis, physical properties, and deleterious substances.
 - 2. Coarse aggregates for conformity to ASTM C33 – sieve analysis, physical properties, and deleterious substances.
 - 3. Cements for conformity to ASTM C150 – chemical analysis and physical properties.
 - 4. Cements, fine aggregates, coarse aggregates, and admixtures for conformity to NSF/ANSI Standard 61.
 - 5. Proposed concrete mix design(s) – compressive strength, slump, shrinkage, and air content (entrapped + entrained).
- H. The Contractor shall provide field testing services of the concrete by an independent testing agency, acceptable to the Engineer but employed by and at the expense of the Contractor. Testing of the following items shall be performed to verify conformity with this Specification Section.
 - 1. Concrete placement – compressive strength (cylinders), compressive strength (cores), slump, air content, and shrinkage (concrete bars).
 - 2. Other materials or products that may come under question.
- I. All materials incorporated in the work shall conform to accepted samples.

1.06 DELIVERY, HANDLING, AND STORAGE

- A. Cement – Store cement in weathertight buildings, bins, or silos to provide protection from dampness and contamination and to minimize warehouse set.
- B. Aggregate – Arrange and use stockpiles to avoid excessive segregation or contamination with other materials or with other sizes of like aggregates. Complete each layer before the next is started. Do not use frozen or partially frozen aggregate.
- C. Sand – Arrange and use stockpiles to avoid contamination. Allow sand to drain to uniform moisture content before using. Do not use frozen or partially frozen sands.
- D. Admixtures – Store in closed containers to avoid contamination, evaporation, or damage. Provide suitable agitating equipment to assure uniform dispersion of ingredients in admixture solutions that tend to separate. Protect liquid admixtures from freezing and other temperature changes that could adversely affect their characteristics.
- E. Sheet Curing Materials – Store in weathertight buildings or off the ground and under cover.

- F. Liquid curing compounds – Store in closed containers.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. Like items of materials shall be the end products of one manufacturer in order to provide standardization for appearance, maintenance, and manufacturer's services.

2.02 MATERIALS

- A. Materials shall comply with this Section and any applicable state or local requirements.
- B. Cement – Domestic Portland cement shall comply with ASTM C150 Type II. Air-entraining cement shall not be used. The cement brand shall be subject to approval by the Engineer and one brand shall be used throughout the Work. Cement shall be certified NSF/ANSI Standard 61 compliant.
- C. Fine Aggregates – Fine aggregates shall be washed inert natural sand conforming to the requirements of ASTM C33. Fine aggregates shall be certified NSF/ANSI Standard 61 compliant.
- D. Coarse Aggregates – Coarse aggregates shall be well-graded crushed stone or washed gravel conforming to the requirements of ASTM C33. Grading requirements shall be as listed in ASTM C33 Table 2 for the specified course aggregate size number. Limits of deleterious substances and physical property requirements shall be as listed in ASTM C33 Table 3 for severe weathering regions. Size numbers for concrete mixes shall be as shown in Table 1 herein. Coarse aggregates shall be certified NSF/ANSI Standard 61 compliant.
- E. Water – Water shall be potable and free from injurious amounts of oil, acids, alkalis, salts, organic matter, or other deleterious substances. Use of reclaimed water or recycled water is not permitted.
- F. Admixtures – Admixtures shall be free of chlorides and alkalis (except for those attributable to water). When it is required to use more than one admixture in a concrete mix, the admixtures shall be from the same manufacturer. Admixtures shall be compatible with the concrete mix including other admixtures. Admixtures shall be certified NSF/ANSI Standard 61 compliant.
 - 1. Air-Entraining Admixture – The admixture shall comply with ASTM C260. Proportioning and mixing shall be in accordance with manufacturer's recommendations.
 - 2. Admixtures causing retarded or accelerated setting of concrete shall not be used without written approval from the Engineer. When allowed, the admixtures shall be retarding or accelerating water-reducing or high-range water-reducing admixtures.
 - 3. Water-Reducing Admixture – The admixture shall comply with ASTM C494, Type A. Proportioning and mixing shall be in accordance with manufacturer's recommendations.
 - 4. High-Range Water-Reducer (Plasticizer) – The admixture shall comply with ASTM C494, Type F and shall result in non-segregating plasticized concrete with little bleeding and with the physical properties of low water/cementitious ratio concrete. The treated concrete shall be capable of maintaining its plastic state in

excess of 2 hours. Proportioning and mixing shall be in accordance with manufacturer's recommendations.

- G. Pozzolan (Fly Ash) – Use of Pozzolans within the concrete mix is not permitted.
- H. Granulated Ground Blast Furnace Slag (GGBFS) - Use of granulated ground blast furnace slag within the concrete mix is not permitted.
- I. Sheet Curing Material – Sheet curing material shall be waterproof paper, polyethylene film, or white burlap-polyethylene sheeting, all of which must comply with ASTM C171.
- J. Liquid Curing Compound – Liquid membrane-forming curing compound shall comply with the requirements of ASTM C309, Type 1-D (clear or translucent with fugitive dye) and shall contain no wax, paraffin, or oil. Curing compound shall be certified NSF/ANSI Standard 61 compliant (nontoxic and free of taste or odor).

2.03 CONCRETE MIXES

- A. Development of mix designs and testing shall be by an independent testing laboratory acceptable to the Engineer but engaged by and at the expense of the Contractor.
- B. Select proportions of ingredients to meet the design strength and materials limits specified in Table 1 and to produce concrete having proper placability, durability, strength, appearance and other required properties. Proportion ingredients to produce a homogenous mixture that will readily work into corners and angles of forms and around reinforcement without permitting materials to segregate or allowing excessive free water to collect on the surface.
- C. The design mix shall be based on standard deviation data of prior mixes with essentially the same proportions of the same constituents or, if such data is not available, be developed by a testing laboratory, acceptable to the Engineer, employed by and at the expense of the Contractor. Acceptance of mixes based on standard deviation shall be based on the modification factors for standard deviation tests contained in ACI 318. The water content of the concrete mix, determined by laboratory testing, shall be based on a curve showing the relation between water cementitious ratio and 7- and 28-day compressive strengths of concrete made using the proposed materials. The curves shall be determined by four or more points, each representing an average value of at least three test specimens at each age. The curves shall have a range of values sufficient to yield the desired data, including the specified design strengths as modified below, without extrapolation. The water content of the concrete mixes to be used, as determined from the curve, shall correspond to strengths 16 percent greater than the specified design strengths. The resulting mix shall not conflict with the limiting values for maximum water-cementitious ratio and net minimum cementitious content as specified in Table 1.
- D. Compression Tests – Provide testing of the proposed concrete mix or mixes to demonstrate compliance with the specified design strength requirements in conformity with the above paragraph.
- E. Shrinkage Tests – Perform shrinkage tests for Class D concrete. The tests shall conform to ASTM C157 as modified by ASTM C596. Concrete and not mortar specimens shall be used.
 - 1. The average shrinkage at 25 days of air storage shall not exceed 0.036 percent.
- F. Entrained air content, as measured by ASTM C231, shall be as shown in Table 1.
 - 1. If the air-entraining agent proposed for use in the mix requires testing methods other than ASTM C231 to accurately determine air content, make special note of this requirement in the admixture submittal.
- G. Slump of the concrete as measured by ASTM C143, shall be as shown in Table 1. If a high-range water-reducer (plasticizer) is used, the slump indicated shall be that

measured before plasticizer is added. Plasticized concrete shall have a slump ranging from 7 to 10 inches.

- H. Proportion admixtures according to the manufacturer's recommendations. Two or more admixtures specified may be used in the same mix provided that the admixtures in combination retain full efficiency and have no deleterious effect on the concrete or on the properties of each other.

Table 1. Concrete Mix Requirements

Class	Design Strength (1)	Cement (2)	Fine Aggregate (2)	Coarse Aggregate (3)	Cementitious Content lbs./cu. yd. (min) (4)	
A	2500	C150 Type II	C33	57	440	
B	3000	C150 Type II	C33	57	480	
D	5000	C150 Type II	C33	57	560	
Class	W/C Ratio (Max.) (5)	Fly Ash (6)	AE Range (7)	WR (8)	HRWR (9)	Slump Range Inches
A	0.62	No	3.5 to 5	Yes	No	1-4
B	0.54	No	3.5 to 5	Yes	No	1-3
D	0.44	No	3.5 to 5	Yes	No	3-5

NOTES:

- (1) Minimum compressive strength in pounds per square inch (psi) at 28 days
- (2) ASTM designation
- (3) Size Number in ASTM C33
- (4) Cementitious content in pounds per cubic yard
- (5) W/C is water-cementitious ratio by weight
- (6) Use of Pozzolans and/or GGBFS is not permitted
- (7) AE is percent air entrainment. Limit total air content to 3 percent for slabs receiving a steel trowel finish.
- (8) WR is water-reducer admixture
- (9) HRWR is high-range water-reducer admixture

PART 3 - EXECUTION

3.01 MEASURING MATERIALS

- A. Concrete shall be composed of Portland cement, fine aggregate, coarse aggregate, water, and admixtures as specified and shall be produced by a plant acceptable to the Engineer. All constituents, including admixtures, shall be batched at the plant except a high-range water-reducer may be added in the field.
- B. Measure materials for batching concrete by weighing in conformity with and within the tolerances given in ASTM C94 except as otherwise specified. Scales shall have been certified by the local Sealer of Weights and Measures within one year of use.

- C. Measure the amount of free water in fine aggregates within 0.3 percent with a moisture meter. Compensate for varying moisture contents of fine aggregates. Record the number of gallons of water as batched on printed batching tickets.
- D. Admixtures shall be dispensed either manually using calibrated containers or measuring tanks, or by means of an automatic dispenser approved by the manufacturer of the specific admixture.
 - 1. Charge air-entraining and chemical admixtures into the mixer as a solution using an automatic dispenser or similar metering device.
 - 2. Inject multiple admixtures separately during the batching sequence.

3.02 MIXING AND TRANSPORTATION

- A. Concrete shall be ready-mixed concrete. No hand mixing will be permitted. Clean each transit mix truck drum and reverse drum rotation before the truck proceeds under the batching plant. Equip each transit-mix truck with a continuous, nonreversible, revolution counter showing the number of revolutions at mixing speeds.
- B. Ready-mix concrete shall be transported to the site in watertight agitator or mixer trucks loaded not in excess of their rated capacities as stated on the nameplate.
- C. Keep the water tank valve on each transit truck locked at all times. Any addition of water must be approved by the Engineer. Added water shall be incorporated by additional mixing of at least 35 revolutions. All added water shall be metered, and the amount of water added shall be shown on each delivery ticket. Addition of additional water is not permitted if any of the following occur:
 - 1. The maximum slump value listed in Table 1 is exceeded.
 - 2. The maximum water-cementitious ratio listed in Table 1 is exceeded.
 - 3. More than 1/4 cubic yard of concrete has been discharged from the mixer/truck.
- D. All central plant and rolling stock equipment and methods shall comply with ACI 318 and ASTM C94.
- E. Select equipment of size and design to ensure continuous flow of concrete at the delivery end. Metal or metal-lined non-aluminum discharge chutes shall be used and shall have slopes not exceeding 1 vertical to 2 horizontal and not less than 1 vertical to 3 horizontal. Chutes more than 20 feet long and chutes not meeting slope requirements may be used if concrete is discharged into a hopper before distribution.
- F. Retempering (mixing with or without additional cement, aggregate, or water) of concrete or mortar that has reached initial set will not be permitted.
- G. Handle concrete from mixer to placement as quickly as practicable while providing concrete of required quality in the placement area. Dispatch trucks from the batching plant so they arrive at the work site just before the concrete is required, thus avoiding excessive mixing of concrete while waiting, or delays in placing successive layers of concrete in the forms.
- H. Furnish a delivery ticket for ready-mixed concrete to the Engineer as each truck arrives. Each ticket shall provide a printed record of the weight of cement and each aggregate as batched individually. Use the type of indicator that returns for zero punch or returns to zero after a batch is discharged. Clearly indicate the weight of fine and coarse aggregate, cement, and water in each batch, the quantity delivered, the time any water is added, and the numerical sequence of the delivery. Show the time of day batched and time of discharge from the truck. Indicate the number of revolutions of the truck mixer.

3.03 TEMPERATURE AND MIXING TIME CONTROL

- A. In cold weather, do not allow the as-mixed temperature of the concrete and concrete temperatures at the time of placement in the forms to drop below 40 degrees Fahrenheit.
- B. If water or aggregate has been heated, combine water with aggregate in the mixer before cement is added. Do not add cement to mixtures of water and aggregate when the temperature of the mixture is greater than 90 degrees Fahrenheit.
- C. In hot weather, cool ingredients before mixing to maintain temperature of the concrete below the maximum placing temperature of 90 degrees Fahrenheit. If necessary, substitute well-crushed ice for all or part of the mixing water.
- D. The maximum time interval between the addition of mixing water and/or cement to the batch and the placing of concrete in the forms shall not exceed the values shown in Table 2.
- E. If an approved high-range water-reducer (plasticizer) is used to produce plasticized concrete, the maximum time interval shall not exceed 90 minutes.

Table 2. Maximum Time to Discharge of Concrete

Air or Concrete Temperature (Whichever is Higher)	Maximum Time (Minutes)
70 to 90 Degrees F (21 to 32 Degrees C)	60
40 to 69 Degrees F (5 to 20 Degrees C)	90
F = Fahrenheit, C = Celsius	

3.04 CONCRETE APPEARANCE

- A. Concrete mix showing either poor cohesion or poor coating of the coarse aggregate with paste shall be remixed. If this does not correct the condition, the concrete shall be rejected. If the slump is within the allowable limit, but excessive bleeding, poor workability, or poor finishability are observed, changes in the concrete mix shall be obtained only by adjusting one or more of the following:
 - 1. The gradation of the aggregate
 - 2. The proportion of fine and coarse aggregate
 - 3. The percentage of entrained air, within the allowable limits
- B. Concrete for the work shall provide a homogeneous structure which, when hardened, will have the required strength, durability and appearance. Mixtures and workmanship shall be such that concrete surfaces, when exposed, will require no finishing. When concrete surfaces are stripped, the concrete, when viewed in good lighting from 10 feet away, shall be pleasing in appearance, and at 20 feet shall show no visible defects.

3.05 PLACING AND COMPACTING

- A. Placing:
 - 1. Placing of all concrete shall be in accordance with the recommendations contained in ACI 304R.
 - 2. Verify that all formwork completely encloses concrete to be placed and is securely braced before concrete placement. Remove ice, excess water, dirt, and other foreign materials from forms. Confirm that reinforcement and other embedded items are securely in place. Have a competent worker at the location of the placement that can assure that reinforcing steel and embedded items

remain in designated locations while concrete is being placed. Sprinkle semi-porous sub grades or forms to eliminate suction of water from the mix. Seal extremely porous sub grades in an approved manner.

3. Deposit concrete as near to its final position as possible to avoid segregation due to rehandling or flowing. Place concrete continuously at a rate that ensures the concrete is being integrated with fresh plastic concrete. Do not deposit concrete that has partially hardened or has been contaminated by foreign materials or on concrete that has hardened sufficiently to cause formation of seams or planes of weakness within the section. If the section cannot be placed continuously, place construction joints as specified or as approved.
4. Pumping of concrete will be permitted. Use a mix design and aggregate sizes suitable for pumping and submit for approval.
5. Remove temporary spreaders from forms when the spreader is no longer useful. Temporary spreaders may remain embedded in concrete only when made of galvanized metal or concrete and if prior approval from the Engineer has been obtained.
6. Do not place concrete for supported elements until concrete previously placed in the supporting element (columns, slabs, and/or walls) has reached adequate strength.

B. Slabs:

1. After suitable bulkheads, screeds, and jointing materials have been positioned, the concrete shall be placed continuously between construction joints beginning at a bulkhead, edge form, or corner. Each batch shall be placed into the edge of the previously placed concrete to avoid stone pockets and segregation.
2. Avoid delays in casting. If there is a delay in casting, the concrete placed after the delay shall be thoroughly spaded and consolidated at the edge of that previously placed to avoid cold joints. Concrete shall then be brought to correct level and struck off with a straightedge. Bullfloats or darbies shall be used to smooth the surface, leaving it free of humps or hollows.
3. "Jitterbugs" shall not be used on slab surfaces to aid in finishing.

C. Formed Concrete:

1. Place concrete in forms using tremie tubes and taking care to prevent segregation. Bottom of tremie tubes shall preferably be in contact with the concrete already placed. Do not permit concrete to drop freely more than 4 feet. Place concrete for walls in 12 to 24-inch lifts, keeping the surface horizontal. If plasticized concrete is used, the maximum lift thickness may be increased to 7 feet and the maximum free fall of concrete shall not exceed 15 feet.

D. Compacting:

1. Consolidate concrete by vibration, puddling, spading, rodding, or forking so that concrete is thoroughly worked around reinforcement, embedded items and openings and into corners of forms. Puddling, spading, etc. shall be continuously performed along with vibration of the placement to eliminate air or stone pockets that may cause honeycombing, pitting, or planes of weakness.
2. All concrete shall be placed and compacted with mechanical vibrators. The number, type, and size of the units shall be approved by the Engineer in advance of placing operations. No concrete shall be ordered until sufficient approved vibrators (including standby units in working order) are on the job site.
3. A minimum frequency of 7,000 revolutions per minute is required for mechanical vibrators. Insert and withdraw vibrators vertically at points from 18 to 30 inches

apart. At each insertion, vibrate sufficiently to consolidate concrete, generally from 5 to 15 seconds. Do not over-vibrate so as to segregate. Keep a spare vibrator on the site during concrete placing operations.

4. Concrete Slabs - Concrete for slabs less than 8 inches thick shall be consolidated with vibrating screeds; slabs greater than or equal to 8 inches thick shall be compacted with internal vibrators and (optionally) with vibrating screeds. Vibrators shall always be placed into concrete vertically and shall not be laid horizontally or laid over.
5. Walls - Internal vibrators (rather than form vibrators) shall be used unless otherwise approved by the Engineer. In general, for each vibrator needed to melt down the batch at the point of discharge, one or more additional vibrators must be used to densify, homogenize, and perfect the surface. The vibrators shall be inserted vertically at regular intervals, through the fresh concrete and slightly into the previous lift, if any.
6. Amount of Vibration: Vibrators are to be used to consolidate properly placed concrete but shall not be used to move or transport concrete in the forms. Vibration shall continue until the following conditions are met:
 - a. The frequency returns to normal.
 - b. The surface appears liquefied, flattened, and glistening.
 - c. Trapped air ceases to rise.
 - d. Coarse aggregate has blended into the surface but has not disappeared.

3.06 CURING AND PROTECTION

- A. Protect all concrete work against injury from the elements and defacements of any nature during construction operations.
- B. Curing Methods:
 1. Curing Methods for Concrete Surfaces – Cure concrete to retain moisture and maintain specified temperature at the surface for a minimum of 7 days after placement. Curing methods to be used are as follows:
 - a. Water Curing – Keep entire concrete surface wet by ponding, continuous sprinkling or covered with saturated burlap. Begin wet cure as soon as concrete attains an initial set and maintain continuous wet cure 24 hours a day.
 - b. Sheet Material Curing – Cover entire surface with sheet material. Securely anchor sheeting to prevent wind and air from lifting the sheeting or entrapping air under the sheet. Place and secure sheet as soon as initial concrete set occurs.
 - c. Liquid Membrane Curing – Apply curing compound over the entire concrete surface except for surfaces to receive additional concrete. Curing compound shall NOT be placed on any concrete surface where additional concrete is to be placed, where concrete sealers or surface coatings are to be used, or where the concrete finish requires an integral floor product. Curing compound shall be applied as soon as the free water on the surface has disappeared and no water sheen is visible, but not after the concrete is dry or when the curing compound can be absorbed into the concrete. Application shall be in compliance with the manufacturer's recommendations.
- C. Specified Applications of Curing Methods:
 1. Slabs for Water Containment Structures – Use water curing only.

2. Slabs on Grade and Footings (not used to contain water) – Water curing, sheet material curing, or liquid membrane curing shall be used.
 3. Structural Slabs (other than water containment), not including Slabs on Grade – Water curing or liquid membrane curing shall be used.
 4. Horizontal Surfaces that will Receive Additional Concrete, Coatings, Grout or Other Material that Requires Bond to the substrate – Water curing shall be used.
 5. Formed Surfaces – No curing shall be used if nonabsorbent forms are left in place 7 days. Water curing shall be used if absorbent forms are used. Sheet curing or liquid membrane curing shall be used if forms are removed before 7 days. Exposed horizontal surfaces of formed walls or columns shall be water cured for 7 days or until next placement of concrete is made. Concrete for formed water containment structures shall only be cured by water and sheet material curing.
 6. Concrete Joints – Water curing or sheet material curing shall be used.
- D. Finished surfaces and slabs shall be protected from the direct rays of the sun to prevent checking and crazing.

3.07 REMOVAL OF FORMS

- A. Except as otherwise specifically approved by the Engineer, forms shall not be removed before the concrete has attained a strength of at least 30 percent of its specified design strength, nor before reaching 100 degree-days of curing for walls and vertical surfaces, and 500 degree-days of curing for beams and slabs, (whichever is the longer). Degree-days are defined as the total number of 24-hour periods multiplied by the weighted average daily air temperature at the surface of the concrete (e.g., 5 days at an average 70 deg. F = 350 degree-days).
1. Forms for the edges of a slab-on-grade may be removed after 100 degree-days.
- B. Shores shall not be removed until the concrete has attained at least 60 percent of its specified design strength and also sufficient strength to support safely its own weight and construction live loads.

3.08 FIELD QUALITY CONTROL

- A. Inspection and Field Testing
1. The batching, mixing, transporting, placing, and curing of concrete shall be subject to the inspection of the Engineer at all times. The Contractor shall advise the Engineer of their readiness to proceed at least 24 hours before each concrete placement. The Engineer will inspect the preparations for concreting including the preparation of previously placed concrete, the reinforcing steel and the alignment, and the cleanliness and tightness of formwork. No placement shall be made without the inspection and acceptance of the Engineer.
 2. Sets of field control concrete cylinder specimens in compliance with ASTM C31 and concrete bars for shrinkage testing shall be taken during the progress of the work by an independent testing agency, acceptable to the Engineer, employed by and at the expense of the Contractor. The number of sets of concrete test cylinders taken of each class of concrete placed each day shall not be less than one set per day, nor less than one set for each 150 cubic yards of concrete, nor less than one set for each 3,000 square feet of surface area for slabs or walls. If the total volume of concrete were such that the frequency of testing required for a given class of concrete would provide less than five strength tests, tests shall be made from at least five randomly selected batches or from each batch if fewer than five batches are anticipated.

3. A "set" of test cylinders consists of six cylinders: two to be tested at 7 days and two to be tested and their strengths averaged at 28 days. The final two may be used for a special test at 3 days or to verify strength after 28 days if 28-day test results are low. The Contractor shall provide a copy of all concrete test results to the District for their review.
 4. When the average 28-day compressive strength of the cylinders in any set falls below the specified design strength or below proportional minimum 7-day strengths (where proper relationships between 7 and 28-day strengths have been established by tests), proportions, water content, or temperature conditions shall be changed to achieve the required strengths.
 5. The Contractor shall cooperate in the making of tests by allowing free access to the work for the selection of samples; providing an insulated, closed curing box for specimens; affording protection to the specimens against injury or loss through the operations; and furnishing material and labor required for the purpose of taking concrete cylinder samples. All shipping of specimens will be paid for by the Contractor. Curing boxes shall be acceptable to the Engineer.
- B. Concrete Slump:
1. Slump tests will be made in the field immediately before placing the concrete by an independent testing agency, acceptable to the Engineer, employed by and at the expense of the Contractor. Such tests shall be made in accordance with ASTM C143. If the slump is greater than the specified range, the concrete shall be rejected.
 2. At a minimum the first three trucks shall be tested to establish consistency. Additionally, testing will be performed with each field control concrete cylinder test and each air content test.
 3. The Engineer reserves the right to increase the frequency of testing when deemed necessary.
- C. Air Content:
1. Testing for air content shall be performed on a fresh concrete sample by an independent testing agency, acceptable to the Engineer, employed by and at the expense of the Contractor. Air content testing for concrete made of ordinary aggregates having low absorption shall be performed in compliance with either the pressure method complying with ASTM C231 or by the volumetric method complying with ASTM C173. If lightweight aggregates or aggregates with high absorptions are used, the latter test method shall be used. If air content is below the specified air-entrainment range, air-entraining admixture may be added on-site to bring the concrete within specifications. If measured air content is above the specified air-entrainment range (+1.5 percent or more) listed in Table 1, the concrete shall be rejected.
 2. At a minimum, the first three trucks shall be tested to establish consistency, then every third truck thereafter. Additionally, an air content test shall be performed with each field control concrete cylinder test. Samples for the testing of air content shall be taken at the point of placement and not at the truck chute/hopper.
 3. The Engineer reserves the right to increase the frequency of testing when deemed necessary.
- D. Shrinkage:
1. Field test specimens shall be handled and tested by an independent testing agency, acceptable to the Engineer, employed by and at the expense of the Contractor as specified herein under "Concrete Mixes".

2. One set of three test specimens shall be made and tested from each placement of concrete for water containment structures.
 3. The maximum concrete shrinkage for specimens cast in the field shall not exceed the trial batch maximum shrinkage requirement by more than 25 percent.
 4. If the required shrinkage limitation is not met during construction, the Contractor shall take any or all of the following actions, at no additional cost to the District, to achieve the specified shrinkage requirements. These actions may include changing the source of aggregates, cement, and/or admixtures; reducing water content; washing of aggregate to reduce fines; increasing the number of construction joints; modifying the curing requirements; or other actions designed to minimize shrinkage or the effects of shrinkage.
- E. The Engineer may have cores taken from any questionable area in the concrete work such as construction joints and other locations as required for determination of concrete quality. The results of tests on such cores shall be the basis for acceptance, rejection, or determining the continuation of concrete work.
- F. The Contractor shall cooperate in obtaining cores by allowing free access to the work and permitting the use of ladders, scaffolding and such incidental equipment as may be required. The Contractor shall be responsible for the repair all core holes. The work of cutting and testing the cores will be at the expense of the Contractor.

3.09 FAILURE TO MEET REQUIREMENTS

- A. Should the strengths shown by test specimens made and tested in compliance with the previous provisions fall below the values given in Table 1, the Engineer shall have the right to require changes in proportions outlined to apply to the remainder of the work. Furthermore, the Engineer shall have the right to require additional curing on those portions of the structure represented by the test specimens that failed. The cost of such additional curing shall be at the Contractor's expense. In the event that such additional curing does not give the strength required, as evidenced by core and/or load tests, the Engineer shall have the right to require strengthening or replacement of those portions of the structure that fail to develop the required strength. The cost of all such core borings and/or load tests, and any strengthening or concrete replacement required because strengths of test specimens are below that specified, shall be entirely at the expense of the Contractor. In such cases of failure to meet strength requirements, the Contractor and Engineer shall confer to determine what adjustment, if any, can be made in compliance with Sections titled "Strength" and "Failure to Meet Strength Requirements" of ASTM C94. The "purchaser" referred to in ASTM C94 is the Contractor in this Section.
- B. When the tests on field control specimens of concrete fall below the specified strength, the Engineer will permit check tests for strengths to be made by means of typical cores drilled from the structure in compliance with ASTM C42 and C39. In the case of cores not indicating adequate strength, the Engineer, in addition to other recourses, may require, at the Contractor's expense, load tests on any one of the elements in which such concrete was used. Tests need not be made until concrete has aged 60 days.
- C. Should the strength of test cylinders fall below 60 percent of the required minimum 28-day strength, the concrete shall be rejected and shall be removed and replaced.

3.10 PATCHING AND REPAIRING

- A. This Section requires quality work including adequate forming, proper mixture and placement of concrete, and curing, so completed concrete surfaces will require no patching.
- B. Defective concrete in the opinion of the Engineer, and honeycombed areas shall be repaired in an approved manner and to the satisfaction of the.

- C. As soon as forms have been removed and the concrete surfaces exposed, fins and other projections shall be removed. All exposed surfaces shall be carefully examined, and any irregularities shall be immediately rubbed or ground in a satisfactory manner in order to secure a smooth, uniform, and continuous surface. Plastering or coating of surfaces to be smoothed will not be permitted. No repairs shall be made until after inspection by the Engineer. In no case will extensive patching of honeycombed concrete be permitted. Concrete containing minor voids, holes, honeycombing, or similar depression defects shall be repaired as specified herein. Concrete containing extensive voids, holes, honeycombing, or similar depression defects shall be completely removed and replaced. The Contractor, at their own expense, shall promptly execute all repairs and replacements herein specified.
- D. Defective surfaces to be repaired as specified in above shall be cut back from true line a minimum depth of 1/2 inch over the entire area. Feathered edges will not be permitted. Where chipping or cutting tools are not required in order to deepen the area properly, the surface shall be prepared for bonding by the removal of all laitance or soft material and not less than 1/32-inch depth of the surface film from all hard portions, by means of an efficient sandblast. After cutting and sandblasting, the surface shall be wetted sufficiently in advance of shooting with shotcrete or with cement mortar so that while the repair material is being applied, the surfaces under repair will remain moist, but not so wet as to overcome the suction upon which a good bond depends. The material used for the repair proposed shall contain such proportion of Atlas White Portland Cement as is required to make the color of the patch match the color of the surrounding concrete.
- E. Recesses left by the removal of form ties shall be filled. Immediately after removal of forms, remove plugs and break off metal ties as required by Section 03 10 00. Promptly fill holes upon stripping as follows: moisten the hole with water, followed by a 1/16-inch brush coat of neat cement slurry mixed to the consistency of a heavy paste. Immediately plug the hole with a 1 to 1.5 mixture of cement and concrete sand mixed slightly damp to the touch (just short of "balling"). Hammer the grout into the hole until dense and an excess of paste appears on the surface in the form of a spider web. Trowel smooth with heavy pressure. Avoid burnishing.
- F. Bugholes, which are surface voids resulting from entrapped air and that are revealed when forms are removed, shall be repaired with a repair material acceptable to the Engineer. All bugholes that are a minimum of ¼ inch deep and ¾ inch long shall be repaired.
- G. Surface defects that do not impair structural strength, in the opinion of the Engineer, shall be repaired in an approved manner and to the satisfaction of the Engineer. When patching exposed surfaces, the same source of cement and sand as used in the parent concrete shall be employed. Adjust color if necessary, by addition of proper amounts of Atlas White Portland Cement. Rub lightly with fine Carborundum stone at an age of 1 to 5 days if necessary, to bring the surface down to flush with the parent concrete. Exercise care to avoid damaging or staining the virgin skin of the surrounding parent concrete. Wash thoroughly to remove all rubbed matter.
- H. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete.

3.11 SCHEDULE

- A. Table 3 lists the general applications for the various concrete classes and design strengths.

Table 3. Concrete Schedule

Class	Design Strength (psi)	Description
A	2,500	Concrete fill and pipe, conduit and duct encasements
B	3,000	Concrete overlay slabs, sidewalks and pavements
D	5,000	Walls, slabs on grade, suspended slab and beam systems, columns, grade beams, footings, and all other structural concrete

END OF SECTION

SECTION 03 35 00
CONCRETE FINISHING

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required to finish cast-in-place concrete surfaces as shown on the Drawings and as specified herein.

1.02 RELATED SECTIONS

- A. Section 03 10 00 – Concrete Forms and Accessories
- B. Section 03 15 00 – Concrete Joints and Accessories
- C. Section 03 30 00 – Cast-in-Place Concrete
- D. Section 03 60 00 – Grouts
- E. Section 03 92 20 – Modifications and Repairs to Concrete
- F. Moisture Protection is included in Division 7
- G. Section 09 90 00 – Painting and Coating
- H. Section 09 96 35 – Chemical-Resistant Coatings

1.03 SUBMITTALS

- A. Submit to the Engineer, in accordance with Division 1, product data showing materials of construction and details of application for the following:
 - 1. Concrete Sealer – Submit product data including catalogue cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to required ASTM standards, and Safety Data Sheet. Confirmation that the sealer is compatible with additionally applied coatings shall also be submitted.
 - 2. Concrete Hardener – Submit product data including catalogue cuts, technical data, storage requirements, product life, application requirements, conformity to required ASTM standards, and Safety Data Sheet.

1.04 REFERENCE STANDARDS

- A. ASTM International (ASTM)
 - 1. ASTM C33 – Standard Specification for Concrete Aggregates
 - 2. ASTM C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
 - 3. ASTM C779 – Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. Finish:

1. For concrete that will receive additional applied finishes or materials, the surface finish specified is required for the proper application of the specified manufacturer's products. Where alternate products are approved for use, determine if changes in finish are required and provide the proper finish to receive these products.
2. Changes in finish made to accommodate products different from those specified shall be performed at no additional cost to the District. Submit the proposed new finish and their construction methods to the Engineer for review and approval.

B. Services of Manufacturer's Representative:

1. The Contractor shall make available, upon 72 hours notification, the services of a qualified field representative of the manufacturer of the curing compound, sealer, or hardener to instruct the user on the proper application of the product under the prevailing job conditions. Services of manufacturer's representative shall be at no additional cost to the District.

PART 2 - PRODUCTS

2.01 GENERAL

- A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

2.02 MATERIALS

- A. Concrete sealer shall comply with ASTM C309, Type 1, Class A or B. Concrete sealer must also be compliant with State of California VOC regulations. Concrete sealer shall be Spartan Cote WB II by Edoco (Burke), Kure-N-Seal WB by BASF Building Systems (Sonneborn), or equal.
- B. Concrete Hardener must be compliant with State of California VOC regulations. Concrete hardener shall be Mastercron by BASF Building Systems, Burke Non-Metallic Hardener by Edoco (Burke), or equal.

PART 3 - EXECUTION

3.01 FORMED SURFACES

- A. Forms shall not be removed before the requirements of Section 03 30 00 have been satisfied.
- B. Exercise care to prevent damaging edges or obliterating the lines of chamfers, rustications, or corners when removing the forms or performing any other work adjacent thereto.
- C. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete.
- D. Rough-Formed Surfaces:
1. Immediately after stripping forms and before concrete has changed color, carefully remove all fins and projections.
 2. Promptly fill holes left by tie cones and defects as specified in Section 03 30 00.

E. Rubbed Finish:

1. Immediately upon stripping forms and before concrete has changed color, carefully remove all fins. While the wall is still damp apply a thin coat of medium-consistency neat cement slurry by means of bristle brushes to provide a bonding coat within all pits, air holes, or blemishes in the parent concrete. Avoid coating large areas with slurry at one time.
2. Before slurry has dried or changed color, apply a dry (almost crumbly) grout proportioned by volume and consisting of 1-part cement to 1.5 parts of clean masonry sand having a fineness modulus of approximately 2.3 and complying with the gradation requirements of ASTM C33 for such a material. Grout shall be uniformly applied by means of damp pads of coarse burlap approximately 6 inches square used as a float. Scrub grout into the pits and air holes to provide dense mortar in all imperfections.
3. Allow the mortar to partially harden for 1 or 2 hours depending upon the weather and ambient temperature. If the air is hot and dry, keep the wall damp during this period using a fine fog spray. When the grout is hardened sufficiently so it can be scraped from the surface with the edge of a steel trowel without damaging the grout in the small pits or holes, cut off all that can be removed with a trowel. (Caution: Grout allowed to remain on the wall too long will harden and will be difficult to remove).
4. Allow the surface to dry thoroughly and rub it vigorously with clean, dry burlap to completely remove any dried grout. No visible film of grout shall remain after this rubbing. The entire cleaning operation for any area must be completed the day it is started. Do not leave grout on surfaces overnight. Allow sufficient time for grout to dry after it has been cut off with the trowel so it can be wiped off clean with the burlap.
5. On the day following the repair of pits, air holes, and blemishes, the walls shall again be wiped clean with dry, used pieces of burlap containing old, hardened mortar, which will act as a mild abrasive. After this treatment, there shall be no built-up film remaining in the parent surface. If, however, such a film is present, a fine abrasive stone shall be used to remove all such material without breaking through the surface film of the original concrete. Such scrubbing shall be light and sufficient only to remove excess material without changing the texture of the concrete.
6. A thorough wash-down with stiff bristle brushes shall follow the final bagging or stoning operations. No extraneous materials shall remain on the surface of the wall. The wall shall be sprayed with a fine fog spray periodically to maintain a continually damp condition for at least 3 days after application of the repair grout.
7. Cement slurry rubbed finish can be postponed and applied along one entire side of a structure is complete and cured instead of finishing each wall section immediately after stripping the forms. While postponing rubbed finish, fins and protruding imperfections shall be removed immediately upon stripping forms as specified.

F. Abrasive Blast Finish:

1. Coordinate with Rubbed Finish application. Do not begin until Rubbed Finish operation is complete or before concrete has reached minimum 7-day strength. The Rubbed Finish application may be deleted by the Engineer if the unfinished concrete surface is of superior quality. Apply the abrasive blast finish only where indicated on Drawings.
2. Prepare a sample area of minimum 4 feet high by 16 feet wide and blast finish as directed by Engineer on a portion of new wall construction that will not be

exposed in the final work. The sample area shall contain a variety of finishes obtained with different nozzles, nozzle pressures, grit materials, and blasting techniques for selection by Engineer. The final accepted sample shall remain exposed until completion of all blast finish operations.

3. The blast finish operation shall meet all regulatory agency requirements. The blast finish Contractor shall be responsible for obtaining all required permits and/or licenses.
4. Perform abrasive blast finishing in as continuous an operation as possible, utilizing the same work crew to maintain continuity of finish on each surface or area of work. Maintain patterns or variances in depths of blast as present on the accepted sample.
5. Use an abrasive grit of proper type and gradation as well as equipment and technique to expose aggregate and surrounding matrix surfaces as follows:
 - a. Medium: Generally, expose coarse aggregate - 1/4-inch to 3/8-inch reveal.
6. Abrasive blast corners and edge of patterns carefully, using back-up boards, to maintain uniform corner or edge line. Determine type of nozzle, nozzle pressure, and blasting techniques required to match Architect's samples.
7. Upon completion of the blast finish operation, thoroughly flush finished surfaces with clean, clear water to remove residual dust and grit. Allow to air dry until curing of concrete is complete.

3.02 FLOORS AND SLABS

A. Machine Float:

1. Screed floors and slabs with straightedges to the established grades shown on the Drawings. Immediately after final screeding, a dry cement/sand shake in proportion of two sacks of Portland cement to 350 pounds of coarse natural concrete sand shall be broadcast evenly over the surface at a rate approximately equal to 500 pounds per 1,000 square feet of floor area. Do not sprinkle neat, dry, cement on the surface.
2. The application of the cement/sand shake may be eliminated at the discretion of the Engineer if the base slab concrete exhibits adequate fattiness and homogeneity and the need is not indicated.
3. When the concrete has hardened sufficiently to support the weight of a power float without it digging into or disrupting the level surface, thoroughly float the shake into the surface with a heavy revolving disc type power compacting machine capable of providing 200-pound compaction force distributed over a 24 inch-diameter-disc.
4. Start floating along the walls and around columns and then move systematically across the surface, leaving a matte finish.
5. The compacting machine shall be a "Kelley Power Float with Compaction Control" as manufactured by Kelly Industries, or equal. Troweling machines equipped with float (shoes) blades that are slipped over the trowel blades may be used for floating. Floating with a troweling machine equipped with normal trowel blades will not be permitted. The use of any floating or troweling machine that has water attachments for wetting the concrete surface during finishing will not be permitted.

- B. Hand Float:
1. In lieu of power floating, small areas may be compacted by hand floating. The dry cement/sand shake previously specified shall be used unless specifically eliminated by the Engineer. Screed the floors and slabs with straightedge to the established grades shown on the Drawings. While the concrete is still green, but sufficiently hardened as to support a finisher and kneeboards with no more than 1/4-inch indentation, float to a true, even plane with no course aggregate visible. Use sufficient pressure on the floats to bring moisture to the surface.
- C. Finishing Tolerances:
1. Level floors and slabs to a tolerance of plus or minus 1/8 inch when checked with a 10-foot straightedge placed anywhere on the slab in any direction. Where drains occur, pitch floors to drains such that there are no low spots left undrained. Failure to meet either of the above requirements shall be cause for removal, grinding, or other corrective measure as directed by the Engineer.
- D. Broomed Finish:
1. Machine float concrete as specified above. When the concrete has stiffened sufficiently to maintain small surface indentations, draw a bristle broom lightly across the surface in the direction of drainage, or in the case of walks and stairs, perpendicular to the direction of traffic to provide a nonslip surface.
- E. Steel Trowel Finish:
1. Machine float concrete as specified above, then hand steel trowel to a perfectly smooth hard even finish free from high or low spots or other defects.
 2. Where concrete is greater than 15 feet in each direction, the Contractor may use a power steel trowel provided a minimum of three troweling passes are made of the entire surface.

3.03 CONCRETE SEALER

- A. Prepare and seal floor surfaces indicated on the Drawings as follows:
1. Finish the concrete as specified in the preceding paragraphs and in accordance with the Schedule of Finishing in Paragraph 3.06 below.
- B. Newly Placed Concrete:
1. Surface must be sound and properly finished. Surface is application-ready when it is damp, but not wet and can no longer be marred by a walking worker.
- C. Newly Cured Bare Concrete:
1. Level any spots gouged out by trades. Remove all dirt, dust, droppage, oil, grease, asphalt, and foreign matter. Cleanse with caustics and detergents as required. Rinse thoroughly and allow to dry so that surface is no more than damp, and not wet.
- D. Aged Concrete:
1. Restore surface soundness by patching, grouting, filling cracks, and holes, etc. Surface must also be free of any dust, dirt, and other foreign matter. Use power tools and/or strippers to remove any incompatible sealers or coatings. Cleanse as required, following the procedure indicated under cured concrete.

- E. Methods:
 - 1. Comply with the manufacturer's recommendations to apply sealer so as to form a continuous, uniform film by spray, soft-bristle push broom, long-nap roller, or lamb's wool applicator.
- F. Applications:
 - 1. Two coats are required for curing concrete. Apply the first coat evenly and uniformly as soon as possible after final finishing at the rate of 200 to 400 square feet per gallon. Apply the second coat when all trades are completed and the structure is ready for occupancy, at the rate of 400 to 600 square feet per gallon.
 - 2. For sealing new concrete, both coats shall be applied full strength.
 - 3. For sealing aged concrete, when renovating, dust proofing, and sealing, the first coat should be thinned 10 to 15 percent with reducer per manufacturer's directions.

3.04 CONCRETE HARDENER

- A. Prepare and apply hardener to floor surfaces indicated on the Drawings as follows:
 - 1. Finish the concrete as specified in the preceding paragraphs and in accordance with the "Schedule of Finishing" defined below.
 - 2. Concrete floor hardener shall be applied to green (newly placed) concrete surfaces only.
- B. Methods:
 - 1. Comply with the manufacturer's recommendations in the application of the product.
 - 2. Do not apply dry shake into the bleed water.
- C. Applications:
 - 1. The product shall be applied using a two-pass process ("shakes"). Using a mechanical spreader, spread approximately 1/2 to 2/3 of the required floor hardener evenly over the concrete surface.
 - 2. If the Contractor chooses to broadcast the floor hardener by hand, in lieu of a mechanical spreader, apply each pass perpendicular to the previous application to better ensure complete coverage.
 - 3. Apply the product in quantities prescribed for "medium duty", but not less than 100 pounds per 100 square feet.

3.05 APPROVAL OF FINISHING

- A. All concrete surfaces, when finished, will be inspected by the Engineer.
- B. Surfaces that do not meet the requirements in this Specification in the opinion of the Engineer shall be refinished or reworked to the satisfaction of the Engineer.
- C. After finishing horizontal surfaces, regardless of the finishing procedure specified, the concrete shall be cured in compliance with Section 03 30 00, unless otherwise directed by the Engineer.

3.06 SCHEDULE OF FINISHING

- A. Concrete shall be finished as specified either to remain as natural concrete or to receive an additional applied finish or material under another Section.

- B. Concrete for the following conditions shall be finished as noted on the Drawings and as further specified herein:
1. Concrete to receive dampproofing and waterproofing: Rough-Formed Finish
 2. Concrete not exposed to view and not scheduled to receive an additional applied finish or material: Rough-Formed Finish
 3. Exterior vertical concrete above grade, exposed to view (except surfaces formed with a form liner): Rubbed Finish
 4. Interior vertical concrete exposed to view except in water containment areas: Rubbed Finish
 5. Vertical concrete in water containment areas: Rubbed Finish on exposed surfaces and extending to 2 feet below normal operating water level; Rough-Formed Finish on remainder of submerged areas
 6. Interior and exterior underside of concrete exposed to view: Rubbed Finish
 7. Exterior surfaces exposed to view and indicated to have an abrasive blast finish: Abrasive Blast Finish
 8. Interior or exterior horizontal concrete not requiring floor hardener or sealer: Floated Finish
 9. Interior or exterior horizontal concrete requiring floor hardener or sealer: See paragraphs titled "Concrete Sealer" and "Concrete Hardener" above, and prepare floor in accordance with manufacturer's recommendations
 10. Concrete for exterior walks, interior and exterior stairs: Broomed Finish perpendicular to direction of traffic
 11. Concrete slabs on which process liquids flow or in contact with sludge: Steel Trowel Finish
 12. Concrete tank, basin, and channel bottoms to be covered with grout: See Section 03 60 00

END OF SECTION

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SECTION 03 36 00

ELECTRICAL AND INSTRUMENTATION DUCT ENCASEMENT CONCRETE

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required and place concrete encasement around underground electrical/instrumentation ductwork as shown on the Drawings and as specified herein.

1.02 RELATED SECTIONS

- A. Section 03 15 00 – Concrete Joints and Accessories
- B. Section 03 21 00 – Concrete Reinforcement
- C. Section 03 30 00 – Cast-in-Place Concrete
- D. Furnishing and Installing Electrical Ducts and Conduits is included in Division 26.
- E. Section 31 05 13 – Clearing and Grubbing, Excavation and Earthwork

1.03 SUBMITTALS

- A. All submittals shall be in accordance with the Standard and Special Provisions.
- B. See Section 03 30 00 for submittal requirements.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL

- A. Concrete shall be measured, mixed, and placed, and compacted as required in Section 03 30 00 for Class A concrete and as specified below.
- B. Colorant shall be an integral red oxide coloring pigment used in the proportion of 8 pounds per cubic yard of concrete. The concrete shall be dyed red throughout. Using a surface treatment color to duct banks will not be accepted.
- C. Provide not less than 3 inches of concrete cover between the outside of a duct and the earth.
- D. All duct line concrete pours shall be continuous between manholes or handholes and between manholes or handholes and structures.
- E. Where duct lines pass through concrete walls, concrete envelopes shall be extended through and finished flush with inside surfaces and finished as indicated on the Drawings. Construction joints as shown on the Drawings shall be provided.
- F. All duct encasements shall be reinforced with concrete reinforcement complying with Section 03 21 00.
- G. Duct lines shall be laid in trenches on Class 2 aggregate base not less than 6 inches thick.

END OF SECTION

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SECTION 03 60 00

GROUTS

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install grout complete as shown on the Drawings and as specified herein.
- B. Perform all sampling and furnish all testing of materials and products by an independent testing laboratory acceptable to the Engineer but engaged by and at the expense of the Contractor.

1.02 RELATED SECTIONS

- A. Section 03 10 00 – Concrete Forms and Accessories
- B. Section 03 15 00 – Concrete Joints and Accessories
- C. Section 03 21 00 – Concrete Reinforcement
- D. Section 03 30 00 – Cast-in-Place Concrete
- E. Section 03 92 20 – Modifications and Repairs to Concrete
- F. Section 05 50 00 – Metal Fabrications

1.03 SUBMITTALS

- A. Submit to the Engineer, in accordance with Division 1, submittals including the following:
 - 1. Commercially Manufactured Nonshrink Cementitious Grout – Submit product data including catalogue cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to required ASTM standards, and Safety Data Sheet.
 - 2. Commercially Manufactured Nonshrink Epoxy Grout – Submit product data including catalogue cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to required ASTM standards, and Safety Data Sheet.
 - 3. Cement Grout – The submittal shall include the type and brand of the cement, the gradation of the fine aggregate, product data on any proposed admixtures, and the proposed mix of the grout.
 - 4. Concrete Grout – The submittal shall include data as required for concrete as delineated in Section 03 30 00 and for fiber reinforcement as delineated in Section 03 21 00. This includes the mix design, constituent quantities per cubic yard, and the water/cementitious ratio.
- B. Samples:
 - 1. Submit samples of commercially manufactured grout products when requested by the Engineer.
 - 2. Submit aggregates for use in concrete grout when requested by the Engineer.
- C. Laboratory Test Reports:
 - 1. Submit laboratory test data as required under Section 03 30 00 for concrete to be used as concrete grout.

- D. Certifications:
1. Certify that grout constituents in contact with water are NSF International/American National Standards Institute (NSF/ANSI) Standard 61 compliant, with certification from an independent ANSI/Environmental Laboratory Accreditation Program (ANSI/ELAP)-accredited testing laboratory acceptable to the Engineer but engaged by and at the expense of the Contractor.
 2. Certify that the Contractor is not associated with the independent testing laboratory, nor does the Contractor or its officers have a beneficial interest in the laboratory.

1.04 REFERENCE STANDARDS

- A. ASTM International (ASTM)
1. ASTM C531 – Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing and Polymer Concretes
 2. ASTM C579 – Standard Test Method for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
 3. ASTM C827 – Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
 4. ASTM C1107 – Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
 5. ASTM D695 – Standard Test Method for Compressive Properties of Rigid Plastics
- B. NSF International (NSF)
1. NSF/ANSI Standard 61 – Drinking Water System Components - Health Effects
- C. US Army Corps of Engineers (CRD)
1. CRD-C 621 – Corps of Engineers Specification for Non-shrink Grout
- D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A. Qualifications – Grout manufacturer shall have a minimum of 10 years experience in the production and use of the type of grout proposed for the work.
- B. Pre-Installation Conference – Well in advance of grouting, hold a pre-installation meeting to review the requirements for surface preparation, mixing, placing, and curing procedures for each product proposed for use. Notify the Engineer as well as all parties concerned with the grouting of the meeting at least 10 days before its scheduled date.
- C. Services of Manufacturer's Representative – A qualified field technician of the nonshrink grout manufacturer, specifically trained in the installation of the products, shall attend the pre-installation conference and shall be present for the initial installation of each type of nonshrink grout. Additional services shall also be provided, as required, to correct installation problems. Services of manufacturer's representative shall be provided at no additional cost to the District.
- D. Field Testing – The field testing of Concrete Grout shall be as specified for concrete in Section 03 30 00.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the jobsite in original, unopened packages, clearly labeled with the manufacturer's name, product identification, batch numbers, and printed instructions.
- B. Store materials in full compliance with the manufacturer's recommendations. Total storage time from date of manufacture to date of installation shall be limited to 6 months or the manufacturer's recommended storage time, whichever is less.
- C. Material that becomes damp or otherwise unacceptable shall be immediately removed from the site and replaced with acceptable material at no additional expense to the District.
- D. Nonshrink, cement-based grouts shall be delivered as pre-blended, prepackaged mixes requiring only the addition of water.
- E. Nonshrink epoxy grouts shall be delivered as pre-measured, prepackaged, three-component systems requiring only blending as directed by the manufacturer.

1.07 DEFINITIONS

- A. Nonshrink Grout – A commercially manufactured product that does not shrink in either the plastic or hardened state, is dimensionally stable in the hardened state, and bonds to a clean baseplate.

PART 2 - PRODUCTS

2.01 GENERAL

- A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. All like materials shall be the products of one manufacturer or supplier in order to provide standardization of appearance.

2.02 MATERIALS

- A. Nonshrink Cementitious Grout:
 - 1. Nonshrink cementitious grouts shall meet or exceed the requirements of ASTM C1107, Grades B or C and CRD-C 621. Grouts shall be Portland cement-based, contain a pre-proportioned blend of selected aggregates and shrinkage-compensating agents and shall require only the addition of water. Nonshrink cementitious grouts shall not contain expansive cement or metallic particles. The grouts shall exhibit no shrinkage when tested in conformity with ASTM C827. The minimum 28-day compressive strength of 5,000 pounds per square inch (psi) is required for all non-shrink cementitious grout.
 - 2. General purpose nonshrink cementitious grout shall conform to the standards stated above and shall be SikaGrout 212 by Sika Corp.; NS Grout by The Euclid Chemical Co.; FSP Construction Grout by Five Star Products Inc.; or equal.
 - 3. Flowable (Precision) nonshrink cementitious grout shall conform to the standards stated above and shall be Masterflow 928 by BASF Building Systems; Hi-Flow Grout by the Euclid Chemical Co.; SikaGrout 212 by Sika Corp.; Five Star Grout, by Five Star Products Inc.; or equal.
- B. Nonshrink Epoxy Grout:
 - 1. Nonshrink epoxy-based grout shall be a pre-proportioned, three-component, 100 percent solids system consisting of epoxy resin, hardener, and blended aggregate. It shall have a minimum compressive strength of 10,000 psi in 7 days

when tested in accordance with ASTM C579, Method B, and have a maximum thermal expansion of 30E6 when tested in accordance with ASTM C531. The grout shall be Masterflow 648 CP by BASF Building Systems; Five Star HP Epoxy Grout by Five Star Products, Inc.; Sikadur 42 Grout-Pak by Sika Corp.; E3-HP by the Euclid Chemical Co.; or equal.

C. Cement Grout:

1. Cement grouts shall be a mixture of one-part Portland cement conforming to ASTM C150 Types I, II, or III and one to two parts concrete sand conforming to ASTM C33 with sufficient water to place the grout. The water content shall be sufficient to impart workability to the grout but not to the degree that it will allow the grout to flow.

D. Concrete Grout:

1. Concrete grout shall conform to the requirements of Section 03 30 00 except as specified herein. It shall be proportioned with cement, coarse and fine aggregates, water, water reducer, high-range water-reducer (if required), and synthetic reinforcing fibers to produce a mix having an average strength of 2,900 psi at 28 days, or 2,500 psi nominal strength. Coarse aggregate size shall be 3/8 inch maximum. Slump shall not exceed 5 inches and shall be low as practical yet still retain sufficient workability.
2. Synthetic reinforcing fibers as specified in Section 03 21 00 shall be added to the concrete grout mix at the rate of 1.5 pounds of fibers per cubic yard of grout. Fibers shall be added from the manufacturer's premeasured bags and according to the manufacturer's recommendations in a manner that will ensure complete dispersion of the fiber bundles as single monofilaments within the concrete grout.

E. Water:

1. Water shall be potable, free from injurious amounts of oil, acid, alkali, organic matter, or other deleterious substances. Use of reclaimed or recycled water is not permitted.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Grout shall be placed over cured concrete that has attained its full design strength unless otherwise approved by the Engineer.
- B. Concrete surfaces to receive grout shall be clean and sound; free of ice, frost, dirt, grease, oil, curing compounds, laitance, and paints; and free of all loose material or foreign matter that may affect the bond or performance of the grout.
- C. Roughen concrete surfaces by sandblasting or hydroblasting to ensure bond of the grout to the concrete. Remove loose or broken concrete. Irregular voids or projecting coarse aggregate need not be removed if they are sound, free of laitance, and firmly embedded into the parent concrete.
 1. Air compressors used to clean surfaces in contact with grout shall be the oilless type or equipped with an oil trap in the airline to prevent oil from being blown onto the surface.
 2. Use of mechanical means (scabbling, scarifying, chipping etc.) may only be used for concrete beneath baseplates and with prior approval of the Engineer. Roughening of concrete by mechanical means for large concrete areas to receive concrete grout is not permitted.

- D. Remove all loose rust, oil, or other deleterious substances from metal embedments or bottom of baseplates before the installation of the grout.
- E. Concrete surfaces shall be washed clean and then kept moist for at least 24 hours before the placement of cementitious or cement grout. Saturation may be achieved by covering the concrete with saturated burlap bags, use of a soaker hose, flooding the surface, or other method acceptable to the Engineer. Upon completion of the 24-hour period, visible water shall be removed from the surface before grouting. The use of an adhesive bonding agent in lieu of surface saturation shall only be used when approved by the Engineer for each specific location of grout installation.
- F. Epoxy-based grouts do not require the saturation of the concrete substrate. Surfaces in contact with epoxy grout shall be completely dry before grouting.
- G. Construct grout forms or other leak proof containment as required. Forms shall be lined or coated with release agents recommended by the grout manufacturer. Forms shall be of adequate strength, securely anchored in place and shored to resist the forces imposed by the grout and its placement.
 - 1. Forms for epoxy grout shall be designed to allow the formation of a hydraulic head and shall have chamfer strips built into forms.
- H. Level and align the structural elements and/or equipment bearing plates in accordance with the structural requirements and the recommendations of the equipment manufacturer.
- I. Equipment shall be supported during alignment and installation of grout by shims, wedges, blocks, or other approved means. The shims, wedges, and blocking devices shall be prevented from bonding to the grout by appropriate bond breaking coatings and removed after grouting unless otherwise approved by the Engineer.

3.02 INSTALLATION – GENERAL

- A. Mix, apply, and cure products in strict compliance with the manufacturer's recommendations and this Section.
- B. Have sufficient manpower and equipment available for rapid and continuous mixing and placing. Keep all necessary tools and materials ready and close at hand.
- C. Maintain temperatures of the foundation plate, supporting concrete, and grout between 40 and 90 deg. F during grouting and until grout compressive strength reaches 1,000 psi or as recommended by the grout manufacturer, whichever is longer. Take precautions to minimize differential heating or cooling of baseplates and grout during the curing period.
- D. Take special precautions for hot weather or cold weather grouting as recommended by the manufacturer when ambient temperatures and/or the temperature of the materials in contact with the grout are outside of the 60–90 deg. F range.
- E. Install grout in a manner that will preserve the isolation between the elements on either side of the joint where grout is placed in the vicinity of an expansion joint (EJ) or partial contraction joint (PCJ).
- F. Reflect all existing underlying expansion joints, partial contraction joints, and construction joints (CJ) through the grout.

3.03 INSTALLATION – CEMENT GROUTS AND NONSHRINK CEMENTITIOUS GROUTS

- A. Mix in accordance with manufacturer's recommendations. Do not add cement, sand, pea gravel, or admixtures without prior approval by the Engineer.
- B. Avoid mixing by hand. Mixing in a mortar mixer (with moving blades) is recommended. Pre-wet the mixer and empty excess water. Add pre-measured amount of water for

mixing, followed by the grout. Begin with the minimum amount of water recommended by the manufacturer and then add the minimum additional water required to obtain workability. Do not exceed the manufacturer's maximum recommended water content.

- C. Placements greater than 3 inches in depth shall include the addition of clean washed pea gravel to the grout mix when approved by the manufacturer. Comply with the manufacturer's recommendations for the size and amount of aggregate to be added. Place grout into the designated areas in a manner that will avoid segregation or entrapment of air. Do not vibrate grout to release air or to consolidate the material. Placement should proceed in a manner that will ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.
- D. Place grout rapidly and continuously to avoid cold joints. Do not place cement grouts in layers. Do not add additional water to the mix (retemper) after initial stiffening.
- E. Just before the grout reaches its final set, cut back the grout to the substrate at a 45-degree angle from the lower edge of the bearing plate unless otherwise approved by the Engineer. Finish this surface with a wood float (brush) finish.
- F. Begin curing immediately after form removal, cutback, and finishing. Keep grout moist and within its recommended placement temperature range for at least 24 hours after placement or longer if recommended by the manufacturer. Saturate the grout surface by use of wet burlap, soaker hoses, ponding, or other approved means. Provide sunshades as necessary. If drying winds inhibit the ability of a given curing method to keep grout moist, erect wind breaks until wind is no longer a problem or curing is finished.

3.04 INSTALLATION – NONSHRINK EPOXY GROUTS

- A. Mix in accordance with the procedures recommended by the manufacturer. Do not vary the ratio of components or add solvent to change the consistency of the grout mix. Do not over mix. Mix full batches only to maintain proper proportions of resin, hardener, and aggregate.
- B. Monitor ambient weather conditions and contact the grout manufacturer for special placement procedures to be used for temperatures below 60 or above 90 degrees Fahrenheit.
- C. Place grout into the designated areas in a manner that will avoid entrapment of air. Placement methods shall ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.
- D. Minimize "shoulder" length (extension of grout horizontally beyond baseplate). In no case shall the shoulder length of the grout be greater than the grout thickness.
- E. Finish grout by puddling to cover all aggregate and provide a smooth finish. Break bubbles and smooth the top surface of the grout in conformity with the manufacturer's recommendations.
- F. Epoxy grouts are self-curing and do not require the application of water. Maintain the formed grout within its recommended placement temperature range for at least 24 hours after placing, or longer if recommended by the manufacturer.

3.05 INSTALLATION – CONCRETE GROUT

- A. Screed underlying concrete to the grade shown on the Drawings. Provide the surface with a broomed finish, aligned to drain. Protect and keep the surface clean until placement of the concrete grout.
- B. Remove the debris and clean the surface by sweeping and vacuuming all dirt and other foreign materials. Wash the slab with water using equipment capable of delivering a

minimum water pressure of 8,000 psi. Flushing of debris into tank drain lines will not be permitted.

- C. Saturate the concrete surface for at least 24 hours before placement of the concrete grout. Saturation may be maintained by ponding, by the use of soaker hoses, or by other methods acceptable to the Engineer. Remove excess water just before placement of the concrete grout. Place a cement slurry immediately ahead of the concrete grout so that the slurry is moist when the grout is placed. Work the slurry over the surface with a broom until it is coated with an approximately 1/16 to 1/8-inch-thick cement paste. (A bonding agent composed of one-part Portland cement, 1.5 parts fine sand, an approved bonding admixture, and water, mixed to achieve the consistency of thick paint, may be substituted for the cement slurry.)
- D. Provide grout control joints as indicated on the Drawings.
- E. Finish and cure the concrete grout as specified for cast-in-place concrete.

3.06 SCHEDULE

- A. General Purpose Nonshrink Cementitious Grout - Use at all locations where nonshrink grout is called for on the Drawings except for baseplates greater in area than 3 feet wide by 3 feet long and except for the setting of anchor rods, anchor bolts, or reinforcing steel in concrete.
- B. Flowable Nonshrink Cementitious Grout - Use under all baseplates greater in area than 3 feet by 3 feet. Use at all locations indicated to receive flowable nonshrink grout on the Drawings. The Contractor, at his/her option and convenience, may substitute flowable nonshrink grout for general purpose nonshrink cementitious grout.
- C. Nonshrink Epoxy Grout - Use at all locations specifically indicated to receive epoxy grout.
- D. Cement Grout - Cement grout may be used for grouting of incidental baseplates for structural and miscellaneous steel such as post baseplates for platforms, baseplates for beams, etc. It shall not be used when nonshrink grout is specifically called for on the Drawings or for grouting of primary structural steel members such as columns and girders.
- E. Concrete Grout - Use for overlaying the base concrete under scraper mechanisms of clarifiers, under scraper mechanisms of sedimentation basins, in screw pump troughs, or to allow more control in placing the surface grade. Use at all locations indicated on the Drawings to receive concrete grout.

END OF SECTION

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SECTION 03 92 20

MODIFICATIONS AND REPAIRS TO CONCRETE

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required to cut, remove, repair, or otherwise modify parts of existing concrete structures as shown on the Drawings and as specified herein as necessary to complete the Work. Work under this Section shall also include bonding new concrete to existing concrete.
- B. Work on the project shall conform to all the requirements of ACI Specification 503.7, "Specification for Crack Repair by Epoxy Injection," published by the American Concrete Institute, except as modified by these Contract Documents.

1.02 RELATED SECTIONS

- A. Section 03 10 00 – Concrete Forms and Accessories
- B. Section 03 15 00 – Concrete Joints and Accessories
- C. Section 03 20 00 – Concrete Reinforcement
- D. Section 03 30 00 – Cast-in-Place Concrete
- E. Section 03 60 00 – Grouts
- F. Section 05 50 00 – Metal Fabrications

1.03 SUBMITTALS

- A. Submit to the Engineer, in accordance with Division 1, submittals including the following:
 - 1. Submit manufacturer's technical literature on all product brands proposed for use by the Contractor, to the Engineer for review. The submittal shall include the manufacturer's installation and/or application instructions.
 - 2. When substitutions for acceptable brands of materials specified herein are proposed by the Contractor, submit brochures and technical data of the proposed substitutions to the Engineer for review and approval before delivery to the jobsite.
 - 3. Certify that constituents in contact with water are NSF International/American National Standards Institute (NSF/ANSI) Standard 61 compliant, with certification from an independent ANSI/Environmental Laboratory Accreditation Program (ANSI/ELAP)-accredited testing laboratory acceptable to the Engineer but engaged by and at the expense of the Contractor.

1.04 REFERENCE STANDARDS

- A. American Concrete Institute (ACI)
 - 1. ACI 503.7 – Specification for Crack Repair by Epoxy Injection
- B. ASTM International (ASTM)
 - 1. ASTM C881 – Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
 - 2. ASTM C882 – Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete By Slant Shear

3. ASTM D570 – Standard Test Method for Water Absorption of Plastics
 4. ASTM D638 – Standard Test Method for Tensile Properties of Plastics
 5. ASTM D695 – Standard Test Method for Compressive Properties of Rigid Plastics
 6. ASTM D732 – Standard Test Method for Shear Strength of Plastics by Punch Tool.
 7. ASTM D790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastic and Electrical Insulating Materials
- C. NSF International (NSF)
1. NSF/ANSI Standard 61 – Drinking Water System Components, Health Effects
- D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A. No existing structure or concrete shall be shifted, cut, removed, or otherwise altered until the Engineer gives authorization.
- B. When removing materials or portions of existing structures and when making openings in existing structures, all precautions shall be taken and all necessary barriers, shoring and bracing, and other protective devices shall be erected to prevent damage to the structures beyond the limits necessary for the new work; protect personnel; control dust; and prevent damage to the structures or contents by falling or flying debris. Unless otherwise permitted, shown or specified, line drilling will be required in cutting existing concrete.
- C. Manufacturer Qualifications: The manufacturer of the specified products shall have a minimum of 10 years' experience in the manufacture of such products and shall have an ongoing program of training, certifying, and technically supporting the Contractor's personnel.
- D. Contractor Qualifications: Contractors shall complete a program of instruction in the application of the approved manufacturer's material specified in this Section and provide certification from the manufacturer attesting to their training and status as an approved applicator.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the jobsite in original, unopened packages, clearly labeled with the manufacturer's name, product identification, batch numbers, and printed instructions.
- B. Store materials in full compliance with the manufacturer's recommendations.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. Materials shall comply with this Section and any applicable federal, state and/or local requirements.

2.02 EQUIPMENT

- A. The following equipment is associated with demolition activities associated with minor modifications and repairs to concrete elements.
- B. Mechanical Scarifying Equipment
 - 1. The scarifying equipment shall be a power-operated, mechanical scarifier capable of uniformly scarifying or removing the existing overlay materials from the foundation slabs to the depths required. The equipment shall be self-propelled with sufficient power, traction, and stability to maintain accurate depth of cut and slope.
- C. Hydro-Demolition Equipment
 - 1. The hydro-demolition equipment shall consist of a filtering and pumping unit operating with a self-propelled, computerized robot that utilizes a high-pressure water jet capable of removing existing overlay material from foundations slabs to the depths required. The equipment shall provide a rough, bondable surface and remove all unsound overlay material during the initial pass.
 - 2. Before starting the hydro-demolition operation, the Contractor shall submit a plan for review to the Engineer for control and filtering of all water discharged during the operation. The Contractor, at a minimum, shall block all drains.
 - 3. The Contractor shall provide a system, as necessary, to insure containment of all dislodged overlay material within the removal area in order to protect plant personnel and adjacent equipment from flying debris.
 - 4. Cleaning shall be performed with a vacuum system capable of removing wet debris and water all in the same pass. The vacuum equipment shall be capable of washing the foundation slab with pressurized water before the vacuum operation to dislodge all debris and slurry from the slab. Cleaning shall be done in a timely manner, before debris and water is allowed to dry on the slab surface.
- D. Handheld Blast-Cleaning Equipment
 - 1. Handheld blast-cleaning equipment shall be either sand or water as necessary to expose fine and coarse aggregates, thoroughly clean all exposed reinforcing steel, and remove any unsound overlay material or laitance layers from the existing surface. If sandblasting is utilized, the equipment shall have oil traps. If water-blasting equipment is utilized, the equipment must be capable of delivering a minimum water pressure of 8,000 pounds per square inch.
- E. Power-Driven Hand Tools
 - 1. Power driven hand tools and jackhammers will be permitted but shall not be heavier than the nominal 35-pound (lb) class. Chipping hammers shall not be heavier than the nominal 15-lb class. Only hand chipping tools shall be used when removing concrete within 1 inch of reinforcing steel. Mechanically driven tools shall be operated at a maximum angle of 45 degrees to the slab or wall surface.

2.03 MATERIALS

- A. Epoxy Bonding Agent:
 - 1. Epoxy bonding agent shall be a two-component, solvent-free, moisture-insensitive epoxy resin material used to bond plastic concrete to hardened concrete complying with the requirements of ASTM C881, Type II.
 - 2. Color shall be concrete gray.

3. Product shall be Sikadur 32 Hi-Mod by Sika Corporation or equal.
- B. Epoxy Paste:
1. Epoxy paste shall be a two-component, solvent-free, moisture insensitive epoxy-resin material used to bond dissimilar materials to concrete in situations such as setting railing posts into hardened concrete and shall comply with the requirements of ASTM C881, Type I, Grade 3. Epoxy paste may also be used to patch existing surfaces where the glue line is 1/8 inch or less.
 2. Color shall be concrete gray.
 3. Product shall be Sikadur 31 Hi-Mod Gel by Sika Corporation or equal.
- C. Nonshrink Grout and Nonshrink Epoxy Grout shall be as specified in Section 03 60 00.
- D. Post-installed concrete adhesive for setting dowels and/or anchor rods into hardened concrete shall be as specified in Section 05 50 00.
- E. Crack Repair Epoxy Adhesive:
1. Crack Repair Epoxy Adhesive shall be a two-component, solvent-free moisture insensitive epoxy-resin material suitable for crack grouting by injection or gravity feed. Crack Repair Epoxy Adhesive shall be formulated for the specific size of opening or crack being injected.
 2. For standard applications, product shall be Sikadur 35 Hi-Mod LV by Sika Corporation or equal.
- F. Repair Mortar (Polymer-Modified Portland Cement Mortar):
1. Horizontal Surfaces:
 - a. Repair mortar is a two-component polymer-modified, Portland cement-based mortar used to repair horizontal surfaces with a migrating corrosion inhibitor and having a minimum compressive strength at 28 days of 7,000psi tested in accordance with ASTM C 881 or ASTM C 109.
 - b. When using in structures containing potable water or water to be treated for potable use the repair mortar used shall be certified by ANSI/NSF 61 for use in potable water applications.
 - c. For standard applications, product shall be SikaTop 122 Plus by Sika Corporation or equal.
 2. Vertical and Overhead Surfaces:
 - a. Repair mortar is a two-component polymer-modified, Portland cement-based, fast setting, non-sag mortar used to repair vertical and overhead surfaces with a migrating corrosion inhibitor and having a minimum compressive strength at 28 days of 7,000 psi tested in accordance with ASTM C 881 or ASTM C 109.
 - b. When using in structures containing potable water or water to be treated for potable use the repair mortar used shall be certified by ANSI/NSF 61 for use in potable water applications.
 3. For standard applications, product shall be SikaTop 123 Plus by Sika Corporation or equal.

PART 3 - EXECUTION

3.01 GENERAL

- A. Cut, repair, reuse, demolish, excavate, or otherwise modify parts of the existing structures, as indicated on the Drawings, specified, or necessary to permit completion of

the Work. Finishes, joints, reinforcements, sealants, etc. are specified in other Sections of this Specification. All work shall comply with other requirements of this Section and as shown on the Drawings.

- B. All commercial products specified in this Section shall be stored, mixed, and applied in strict compliance with the manufacturer's recommendations.
- C. In all cases where concrete is repaired in the vicinity of an expansion joint (EJ) or partial contraction joint (PCJ), the repairs shall be made to preserve the isolation between components on either side of the joint.
- D. When drilling holes for dowels/bolts at new or existing concrete, drilling shall stop if rebar is encountered. As approved by the Engineer, the hole location shall be relocated to avoid rebar. The Contractor shall not cut rebar without prior approval of the Engineer. Where possible, rebar locations shall be identified before drilling using non-destructive methods, "rebar locators," so that drilled hole locations may be adjusted to avoid rebar interference.
- E. When coring new openings at new or existing concrete, the Contractor shall identify existing rebar locations using non-destructive methods, "rebar locators." Where possible and as approved by the Engineer, the Contractor shall locate the new hole to avoid and/or minimize rebar interference. The Contractor shall not cut existing rebar without prior approval from the Engineer.

3.02 CONCRETE REMOVAL

- A. Unless otherwise noted, concrete designated to be removed to specific limits as shown on the Drawings or directed by the Engineer shall be removed by line drilling at limits followed by chipping or jack-hammering as appropriate in areas where concrete is to be taken out. Remove concrete in such a manner that surrounding concrete or existing reinforcing to be left in place and existing in place equipment is not damaged. Sawcutting at limits of concrete to be removed shall only be done if indicated on the Drawings, or after obtaining written approval from the Engineer.
- B. Where the joint between new concrete or grout and existing concrete will be exposed in the finished work, the edge of concrete removal shall be a 1-inch-deep saw-cut on each exposed surface of the existing concrete.
- C. Where existing reinforcing is exposed due to saw-cutting/core-drilling and no new material is to be placed on the saw-cut surface, a coating or surface treatment of epoxy paste shall be applied to the entire cut surface to a thickness of 1/4 inch.
- D. Concrete specified to be left in place that is damaged by the Contractor, in the opinion of the Engineer, shall be repaired by approved means to the satisfaction of the Engineer at the Contractor's expense.
- E. The Engineer may from time to time direct the Contractor to make additional repairs to existing concrete. These repairs shall be made as specified or by such other methods as may be appropriate.

3.03 CONNECTION SURFACE PREPARATION

- A. Connection surfaces shall be prepared as specified below for concrete areas requiring patching, repairs, or modifications as shown on the Drawings, as specified, or as directed by the Engineer.
- B. Remove all deteriorated materials, dirt, oil, grease, and all other bond-inhibiting materials from the surface by hydro-blasting or sand/shot-blasting, as approved by the Engineer. Surfaces shall be roughened to a full amplitude of at least 1/2-inch depth. Irregular voids or surface stones need not be removed if they are sound, free of laitance, and firmly embedded into parent concrete, subject to the Engineer's final inspection. If impact

removal techniques are employed (e.g., bush-hammering, scabbling, jackhammering, etc.), subsequent removal of the micro-fractured surface by hydro-blasting, shot-blasting, or by wet or dry sandblasting shall be required.

- C. If reinforcing steel is exposed, it must be mechanically cleaned to remove all contaminants, rust, etc., as approved by the Engineer. If half of the diameter of the reinforcing steel is exposed, chip out behind the steel. The distance chipped behind the steel shall be a minimum of 1/2 inch. Reinforcing to be saved shall not be damaged during the demolition operation.
- D. Reinforcing from existing demolished concrete that is shown to be incorporated in new concrete shall be cleaned by mechanical means to remove all loose material and products of corrosion before proceeding with the repair. It shall be cut, bent, or lapped to new reinforcing as shown on the Drawings and provided with 1-inch minimum cover all around.
- E. The following are specific concrete surface preparation and connection "methods" to be used where called for on the Drawings, specified or as directed by the Engineer.
 - 1. Method A – After the existing concrete surface at the connection has been roughened and cleaned, thoroughly saturate and maintain saturation for a period of at least 12 hours. Remove excess water just before placement of the concrete. Place a cement paste immediately ahead of the concrete so that the paste is moist when the concrete is placed. Work the paste over the surface until it is coated with an approximately 1/16-inch layer of cement paste. Immediately after application of cement paste, place new concrete or grout mixture as detailed on the Drawings.
 - 2. Method B – After the existing concrete surface has been roughened and cleaned, apply epoxy bonding agent at connection surface. The field preparation and application of the epoxy bonding agent shall comply strictly with the manufacturer's recommendations. Place new concrete or grout mixture to limits shown on the Drawings within time constraints recommended by the manufacturer to ensure bond.
 - 3. Method C – Post-installed concrete adhesive dowels shall be set in existing concrete by drilling holes to the required depth to develop the full tensile and shear strengths of the dowel material being used. The post-installed concrete adhesive system shall be installed per the manufacturer's recommendation in holes sized as required. Unless otherwise shown on the Drawings, deformed dowels shall be drilled and set to a depth of 10 bar diameters and smooth dowels shall be drilled and set to a depth of 15 bar diameters. The dowel may be installed in horizontal or vertical positions as indicated on the Drawings.
 - 4. Method D – This method is a combination of Methods B and C.

3.04 GROUTING

- A. Grouting shall be as specified in Section 03 60 00.

3.05 CRACK REPAIR

- A. Cracks on horizontal surfaces shall be repaired by gravity feeding crack repair adhesive into cracks per manufacturer's recommendations. If cracks are less than 1/16 inch in thickness, they shall be pressure injected.
- B. Cracks on vertical surfaces shall be repaired by pressure injecting crack repair adhesive through valves sealed to the surface with crack repair epoxy adhesive per manufacturer's recommendations.

3.06 SPALLED/DETERIORATED CONCRETE REPAIR

- A. Only use polymer-modified cementitious repair mortar for surface repair of spalled or deteriorated concrete.
- B. Comply with manufacturer's recommendations for concrete removal, surface preparation, mixing, application, lift thickness, finishing, moist curing, and form removal.
- C. Saw cut perimeter of deteriorated concrete to form a rectangle with straight edges to depth indicated. Remove fractured, loose, broken, softened, and deteriorated concrete by abrasive blasting, chipping, or other appropriate means to sound concrete. Chip concrete substrate to obtain a surface profile with a new fractured aggregate surface.
- D. Remove dirt, oil, grease, and other bond inhibiting materials from surface by dry mechanical means such as sand blasting, chipping, or wire brushing. Thoroughly clean surface of loose or weakened material and dust by dry mechanical means such as oil-free air blast. Follow recommendations of repair mortar manufacturer for additional surface preparation.
- E. Do not damage reinforcing steel that is to be incorporated into new concrete. Where reinforcing steel with active corrosion is encountered, use following procedure:
 - 1. Use dry mechanical means to remove loose material, contaminants and rust from exposed reinforcing steel.
 - 2. When more than half of reinforcing bar diameter is exposed, chip out behind reinforcing steel, 1 inch minimum.
 - 3. Make distance chipped behind a reinforcing bar equal to or exceed minimum placement depth of material being used, 1 inch minimum.
 - 4. If existing reinforcing steel has lost more than 15 percent of its original cross-sectional area, splice in new reinforcing as shown on Drawings.
- F. Repair cracks encountered in substrate area of spalled or deteriorated concrete repair as specified directed by the Engineer.
- G. Repair Mortar Placement:
 - 1. Follow procedures recommended by manufacturer for mixing and placement of repair mortar.
 - 2. After initial mixing of repair mortar, do not add water to change the consistency, should the mix begin to stiffen.
 - 3. Saturate substrate surface dry (SSD) with no standing water during application.
 - 4. Apply scrub coat to substrate, filling all pores and voids.
 - 5. While scrub coat is still plastic, apply polymer-modified repair mortar. Place repair mortar to an even, uniform plane to restore the member to its original surface.
 - 6. For applications greater than 1 inch in depth, apply repair mortar in lifts. Score exposed surface of each lift to produce a roughened surface before applying the next lift. Allow lift to reach final set before proceeding with subsequent lift.
- H. Finishing:
 - 1. Apply repair mortar with a smooth, steel trowel finish, unless otherwise noted.
 - 2. Have no sharp edges when repair is completed. Make exterior corners, such as at penetrations, with a 1-inch radius. Make interior corners square.

- I. Curing: Perform as recommended by repair mortar manufacturer, except that cure period shall be at least 24 hours and done by means of a continuous fog spray or moist cure with wet burlap.
- J. Repairs Requiring Formwork:
 - 1. Remove fractured, loose, deteriorated, and unsound concrete by bush hammering, chipping, high pressure water blast, or other appropriate dry mechanical means. Remove dirt, oil, grease, and other bond inhibiting materials from concrete surface.
 - 2. Treat existing anchor bolts, exposed reinforcing steel, and reinforcing to be incorporated into repair mortar, as specified below.
 - 3. Construct leakproof forms as required by project conditions. Line or coat forms with release agents recommended by repair mortar manufacturer. Provide forms of adequate strength, securely anchored in place and shored to resist the forces imposed by repair mortar and its placement.
 - 4. Saturate existing concrete surfaces with water, with no standing water during application. Prime concrete surface with a scrub coat of repair mortar. Restore area to original limits or as shown using repair mortar before scrub coat dries. Extend repair mortar with 3/8-inch aggregate only as recommended by manufacturer of repair mortar.

END OF SECTION

SECTION 05 50 00

METAL FABRICATIONS

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required and install all miscellaneous metal complete as shown on the Drawings and as specified herein.

1.02 RELATED SECTIONS

- A. Section 03 10 00 – Concrete Forms and Accessories
- B. Section 03 15 00 – Concrete Joints and Accessories
- C. Section 03 21 00 – Concrete Reinforcement
- D. Section 03 30 00 – Cast-in-Place Concrete
- E. Section 03 60 00 – Grouts
- F. Section 03 92 20 – Modifications and Repairs to Concrete
- G. Section 05 51 00 – Metal Stairs
- H. Section 05 52 00 – Metal Railings
- I. Section 09 90 00 – Painting and Coating

1.03 SUBMITTALS

- A. Submit to the Engineer, in accordance with Division 1, shop drawings and product data showing materials of construction and details of installation for the following.
- B. Layout drawings for grating shall be submitted showing the direction of span, type, and depth, size and shape of panels, seat angle details, and details of hold-down fasteners. Load and deflection tables shall be submitted for each style and depth of grating used.
- C. Welding Procedures – Contractor shall submit Welding Procedure Specification (WPS) and Procedure Qualification Records (PQR) for all welding joint types, as applicable.
- D. An ICC-ES report listing the capacity in tension and shear for each size and type of post-installed concrete anchor used shall be submitted to the Engineer for review.
- E. Contractor shall submit Manufacturer's Printed Installation Instructions (MPII) for all mechanical and adhesive anchors for Engineer's review. Upon favorable review by the Engineer, these instructions shall be followed explicitly.
- F. No substitution for the indicated post-installed mechanical or adhesive anchors will be considered by the Engineer unless accompanied with an ICC-ES report verifying strength and material equivalency.
- G. Samples:
 - 1. Submit 12 by 12-inch samples of metal grating and cover plates, illustrating surface finish, color, texture, and jointing details.
- H. Design Data:
 - 1. Submit manufacturer's load and deflection tables for grating.
- I. Test Reports:

1. Submit a certified copy of mill test reports on each steel and aluminum proposed for use showing the physical properties and chemical analysis.
- J. Certificates:
1. Submit certification that welders are qualified in accordance with AWS on shop and field welding procedures to be used.
 2. Submit certification that adhesive anchor installers are qualified in accordance with the American Concrete Institute/Concrete Reinforcing Steel Institute (ACI/CRSI) Adhesive Anchor Installer Certification program.

1.04 REFERENCE STANDARDS

- A. Federal Specifications:
1. FF-B-575C – Bolts, Hexagonal and Square
 2. MIL-G-18015 A (3) – (Ships) Aluminum Planks (6063-T6)
 3. MIL-A-907E – Antiseize Thread Compound, High Temperature
 4. MIL-P-26915 – Primer Coating, Zinc Dust Pigment
- B. American Association of State Highway and Transportation Officials (AASHTO):
1. Standard Specifications for Highway Bridges – HL93 (HS20) Truck Loading
- C. American Concrete Institute (ACI):
1. ACI 355.2 – Qualification of Post-Installed Mechanical Anchors in Concrete
 2. ACI 355.4 – Qualification of Post-Installed Adhesive Anchors in Concrete
- D. American Institute of Steel Construction (AISC):
1. Steel Construction Manual
- E. ASTM International (ASTM):
1. ASTM A36 – Standard Specification for Carbon Structural Steel
 2. ASTM A48 – Standard Specification for Gray Iron Castings
 3. ASTM A53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
 4. ASTM A108 – Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
 5. ASTM A123 – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 6. ASTM A125 – Standard Specification Steel Springs, Helical, Heat-Treated
 7. ASTM A153 – Standard Specification Zinc Coating (Hot-Dip) on Iron and Steel Hardware
 8. ASTM A193 – Standard Specification for Alloy-Steel and Stainless-Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
 9. ASTM A194 – Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
 10. ASTM A276 – Standard Specification for Stainless Steel Bars and Shapes
 11. ASTM A307 – Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000 PSI Tensile Strength

12. ASTM A384 – Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
13. ASTM A500 – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
14. ASTM A501 – Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
15. ASTM A536 – Standard Specification for Ductile Iron Castings
16. ASTM A563 – Standard Specification for Carbon and Alloy Steel Nuts
17. ASTM A575 – Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
18. ASTM A780 – Standard Practice for Repair of Damage and Uncoated Areas of Hot-Dip Galvanized Coatings
19. ASTM A786 – Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy and Alloy Steel Floor Plates
20. ASTM A992 – Standard Specification for Structural Steel Shapes
21. ASTM A1008 – Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
22. ASTM A1011 – Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability and Ultra-High Strength
23. ASTM B98 – Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes
24. ASTM B201 – Standard Practice for Testing Chromate Coatings on Zinc and Cadmium Surfaces
25. ASTM B209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
26. ASTM B221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes
27. ASTM B695 – Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
28. ASTM C633 – Standard Test Method for Adhesion or Cohesion Strength of Thermal Spray Coatings
29. ASTM D6386 – Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
30. ASTM E140 – Standard Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness
31. ASTM E376 – Standard Practice for Measuring Coat Thicknesses by Magnetic-Field or Eddy-Current (Electromagnetic) Testing Methods
32. ASTM E384 – Standard Test Method for Micro indentation Hardness of Materials
33. ASTM F593 – Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
34. ASTM F594 – Standard Specification for Stainless Steel Nuts

- 35. ASTM F1554 – Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
- 36. ASTM F3125 – Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength
- F. American Welding Society (AWS)
 - 1. ANSI/AWS D1.1 – Structural Welding Code - Steel
 - 2. ANSI/AWS D1.2 – Structural Welding Code - Aluminum
 - 3. ANSI/AWS QC1 – Qualification and Certification of Welding Inspectors
- G. International Code Council Evaluation Services (ICC-ES)
 - 1. Manufacturer Evaluation Reports, as appropriate
- H. National Fire Protection Association (NFPA)
 - 1. NFPA 101 – Life Safety Code
- I. National Association of Corrosion Engineers (NACE)
 - 1. Coating Inspector Program (CIP)
- J. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A. The work of this Section shall be completely coordinated with the work of other Sections. Verify, at the site, both the dimensions and work of other trades adjoining items of work in this Section before fabrication and installation of items herein specified.
- B. Furnish to the pertinent trades all items included under this Section that are to be built into the work of other Sections.
- C. All welding shall be performed by qualified welders and shall conform to the applicable AWS welding code. Welding of steel shall conform to AWS D1.1 and welding of aluminum shall conform to AWS D1.2.
- D. All welding procedures and welder qualification shall be available in the Contractor's field office for Engineer's review.
- E. All welding shall be inspected by a District-provided inspector qualified in accordance with AWS requirements and acceptable to the Engineer.
- F. Unless otherwise directed by the Engineer, the Contractor shall provide the services of an independent, NACE-certified coating inspector. The cost of such work, except as specifically stated otherwise, shall be paid by the Contractor. All shop-applied coatings shall be inspected by an inspector, qualified in accordance with NACE requirements and approved by the Engineer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver items to be incorporated into the work of other trades in sufficient time to be checked before installation.
- B. Items damaged during transit, inadequate storage, improper handling, or corroded, in the opinion of the Engineer, shall be repaired or replaced, at the Contractor's expense, to the satisfaction of the Engineer before incorporating them into the work.

1.07 PROJECT/SITE REQUIREMENTS

- A. Field measurements shall be taken at the site, before fabrication of items, to verify or supplement indicated dimensions and to ensure proper fitting of all items.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. Like items of materials shall be the end products of one manufacturer in order to provide standardization for appearance, maintenance, and manufacturer's service.
- C. Steel - Unless otherwise noted:
 - 1. Shapes, Plates, Bars: ASTM A36, unless otherwise noted.
 - 2. Wide-flange structural steel shapes: ASTM A992.
 - 3. Pipe, Pipe Columns, Bollards: ASTM A53, Type E or S, Grade B standard weight unless noted otherwise.
 - 4. Tubes: ASTM A500 Grade B.
 - 5. Corrosion Protection - Unless otherwise indicated, miscellaneous metalwork of fabricated steel that will be used in a corrosive environment and/or will be submerged in water/wastewater shall be coated in accordance with Section 09 90 00 – Painting and Coating and shall not be galvanized before coating. All other miscellaneous steel metalwork shall be hot-dip galvanized after fabrication as specified herein.
- D. Stainless Steel – Unless otherwise noted:
 - 1. Exterior – Stainless steel plates, sheets, and structural shapes ASTM A167, Type 316 (Type 316L for welding) stainless steel and shall not be galvanized. Where anaerobic conditions are noted, Type 304 stainless steel shall be used.
 - 2. Interior/Architectural – Stainless steel plates, sheets, and structural shapes ASTM A167, Type 316.
- E. Aluminum - Unless otherwise noted:
 - 1. Extruded Pipe ASTM B429, Alloy 6063-T6.
 - 2. Extruded Shapes ASTM B221, Alloy 6061-T6.
 - 3. Sheet and Plate ASTM B209, Alloy 6061-T6.
 - 4. Aluminum in contact with concrete, masonry, wood, porous materials, or dissimilar metals shall have contact surfaces coated in accordance with the Section 09 90 00 – Painting and Coating.
- F. Cast Iron – Unless otherwise noted:
 - 1. Iron castings shall conform to the requirements of ASTM A48, Class 50B or better.
- G. Bolts, Nuts, and Washers – Unless otherwise noted:
 - 1. Carbon Steel Bolts and Studs ASTM A307, Grade A (hot-dip galvanized nuts and washers where noted).
 - 2. Carbon Steel Anchor Bolts for Building Anchorage, ASTM F1554 Grade 36, unless otherwise noted (hot-dip galvanized nuts and washers where noted).

3. Stainless Steel Bolts, Nuts, and Washers, ASTM F593 and ASTM F594, Type 316.
 4. High-Strength Steel Bolts, Nuts, and Washers, ASTM F3125, Grade A325 (mechanically galvanized per ASTM B695, Class 50, where noted).
 5. Elevated Temperatures – Exposure Type I.
 6. General Applications – Exposure Type I or Type II.
- H. Galvanizing – ASTM A123, Zn with 0.5 percent minimum Ni.
- I. Galvanizing – Hardware ASTM A153, Zn with 0.5 percent minimum Ni.

2.02 MISCELLANEOUS ALUMINUM

- A. All miscellaneous aluminum metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item even if such pieces are not definitively shown or specified.
- B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close-fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Welding shall be on the unexposed side as much as possible in order to prevent pitting or discoloration of the aluminum exposed surface. Provide holes for temporary field connections and for attachment of the work of other trades.
- C. Miscellaneous aluminum items shall include beams, angles, closure angles, grates, hatches, floor plates, stop plates, stair nosing, and any other miscellaneous aluminum called for on the Drawings and not otherwise specified.
- D. Angle frames for hatches, beams, grates, etc., shall be complete with welded strap anchors attached.
- E. Aluminum nosing at concrete stairs shall be Alumogrit Treads, Type 116, as manufactured by Wooster Products, Inc.; similar as manufactured by Barry Pattern and Foundry Co.; or equal. Furnish with wing-type anchors and flat head stainless steel machine screws, 12 inches on-center. Nosing shall also be used at concrete ladder openings. Nosing shall be a single piece for each step extending to within 3 inches at each side of stair or full ladder width. Set nosing flush with stair treads finish at concrete stairs. Furnish treads with heavy duty protective tape cover.

2.03 MISCELLANEOUS STEEL

- A. All miscellaneous steel metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item even if such pieces are not definitively shown or specified.
- B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close-fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Provide holes for temporary field connections and for attachment of the work of other trades.

- C. Miscellaneous steel items shall include beams, angles, lintels, support brackets, baseplates for other than structural steel or equipment, closure angles, bridge crane rails, monorail hoist beams, hold-down straps and lugs, door frames, splice plates, sub-framing at roof openings and any other miscellaneous steel called for on the Drawings and not otherwise specified.
- D. Steel pipe pieces for sleeves, lifting attachments, and other functions shall be Schedule 40 pipe unless otherwise shown on the Drawings. Wall and floor sleeves of steel pipe shall have welded circumferential steel waterstops (weep-rings) at mid-length.
- E. All steel finish work shall be thoroughly cleaned, by effective means, of all loose mill scale, rust, and foreign matter and shall be given one shop coat of primer compatible with the finish coat after fabrication but before shipment. Paint shall be omitted within 3 inches of proposed field welds. Paint shall be applied to dry surfaces and shall be thoroughly and evenly spread and well worked into joints and other open spaces.
- F. Galvanizing, where required, shall be the hot-dip zinc process after fabrication. Coating shall be not less than 2 ounces per square foot of surface.

2.04 MISCELLANEOUS STAINLESS STEEL

- A. All miscellaneous stainless-steel metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item even if such pieces are not definitively shown or specified.
- B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close-fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Provide holes for temporary field connections and for attachment of the work of other trades.
- C. Miscellaneous stainless-steel items shall include beams, angles, bar racks, and any other miscellaneous stainless steel called for on the Drawings and not otherwise specified.

2.05 MISCELLANEOUS FRAMING AND SUPPORTS

- A. Provide miscellaneous metal framing, supports, and other metal items required, including framing for architectural infill panels that are not a part of the structural steel framework but are required to complete the work.
- B. Fabricate miscellaneous units to the sizes, shapes, and profiles shown or, if not shown, of the required dimensions to receive adjacent grating, plates, tanks, doors, or other work to be retained by the framing. Except as otherwise shown, fabricate from structural shapes, plates, and bars, of all welded construction using mitered corners, welded brackets, and splice plates and a minimum number of joints for field connection. Cut, drill, and tap units to receive hardware and similar items to be anchored to the Work.
- C. Equip units with integrally welded anchors for casting into concrete. Furnished inserts for units must be installed after concrete is placed.
- D. Except as otherwise shown, space anchors, 24 inches on-center, and provide units equivalent of 1.25 by 1.25 by 8-inch strips.
- E. Galvanize all miscellaneous framing and supports.

2.06 FRAMING SUPPORT SYSTEMS FOR PIPE ASSEMBLIES AND APPURTENANCES

- A. Provide framing support systems for pipe assemblies shown on the Drawings.
- B. Furnish and install all anchoring and connecting hardware required for assembly and installation of the framing support system(s).
- C. All anchoring and connecting hardware shall be Type 316 Stainless Steel.
- D. All exterior framing support systems and all systems within sub-grade vaults, for pipe assemblies and appurtenances shall be fabricated of Type 316 Stainless Steel.
- E. All framing support systems used in interior, non-submerged applications shall be fabricated of low-carbon steel and furnished with a factory-applied, hot-dip, galvanized coating.
- F. Where framing support systems are shown in locations with no adjacent wall, the framing support system shall be free-standing and designed to withstand a point load of 200 pounds applied at the top of the framing system such that the maximum deflection shall not exceed 1/4 inch. Base support members shall be a minimum of 2 feet long and shall use Unistrut P2072ASQ post base, B-Line B280SQ post base, or equal.
- G. Manufacturer – Unless otherwise shown, all members shall be P1000 with type “HS” hole pattern, manufactured by Unistrut, similar by B-Line, or equal.

2.07 METAL GRATING

- A. General: Metal grating shall be of the design, sizes, and types indicated. Grating shall be completely banded at all edges and cutouts using material and cross section equivalent to the bearing bars. Such banding shall be welded to each cut bearing bar. Support members shall support grating on all sides of an opening. Where grating is supported on concrete, embedded support angles matching grating material shall be used on all sides, unless shown otherwise. Such angles shall be mitered and welded at corners.
- B. All pieces of grating shall be securely fastened in two locations to each support. Grating clips, fasteners, anchors, bolts, nuts, and washers for grating and supports shall be Type 316 Stainless Steel.
- C. Where grating forms the landing at the top of a stairway, the edge of the grating that forms the top riser shall have an integral, nonslip nosing, with width equal to that of the stairway.
- D. Where grating depth is not given, grating shall be provided that will be within allowable stress levels, and that shall not exceed a deflection of 1/4 inch or the span divided by 180, whichever is less. For standard duty, and safety grating, the loading to be used for determining stresses and deflections shall be the uniform live load of the adjacent floor or 100 pounds per square foot (psf), whichever is greater, or a concentrated load of 1,000 pounds. For heavy duty grating, the loading used for determining stresses and deflections shall be AASHTO HL93 (HS-20).
- E. At a minimum, grating bars shall be I-bar configuration and be spaced at 1-3/16 inches on-center. Crossbars shall be spaced at 4 inches on-center, unless otherwise noted.
- F. Grating cross bars shall be attached to the bearing bars with interlocked swaged joints having no exposed welding.
- G. Openings 2 inches or greater in diameter/dimension and grating edges shall be banded with a bar of the same depth and thickness as the bearing bars. Cut bearing or cross bars shall be welded to the banding bar.
- H. Unless otherwise designated by the Engineer, the maximum weight of each grating section shall be 80 pounds.

- I. Material:
 - 1. Except where indicated otherwise, bar grating shall be fabricated entirely of aluminum, Alloy 6063-T6.
 - 2. Grating that may be partially or wholly submerged shall be fabricated entirely of stainless steel, Type 316.
 - 3. Grating frames, anchors, and supports shall be all aluminum construction, fabricated from aluminum alloy 6061-T6 or as specified on the Drawings.
- J. Standard Duty Grating:
 - 1. No single piece of grating shall weigh more than 80 pounds, unless indicated otherwise. Standard duty grating shall be serrated bar grating.
 - 2. Crossbars shall be welded or mechanically locked tightly into position so that there is no movement allowed between bearing and cross bars.
- K. Safety Grating:
 - 1. Safety grating shall be made of sheet metal punched into an open serrated diamond pattern and formed into plank sections. The open diamond shapes shall be approximately 1-7/8 inch by 11/16 inch in size. Safety grating shall be Grip Strut by G.S. Metals, Safe-T-Grid by IKG Industries, or equal.

2.08 CHECKERED PLATE

- A. Checkered plate shall be not less than 1/4-inch-thick (3/8-inch plate thickness for aluminum) and shall have a pattern of raised lugs on one face and shall be smooth on the opposite face. Lugs shall be a minimum of 1 inch in length and raised a minimum of 0.050 inch above the surface. The lugs shall be located in a pattern in which the lugs are oriented at 90 degrees from the adjacent lugs in two orthogonal directions. The rows of lugs shall be oriented at 45 degrees from the edges of the plates.
- B. Where no plate material is indicated on the Drawings, aluminum alloy 6061-T6 shall be provided. Unless noted otherwise on the Drawings, the minimum plate thickness shall be as required to limit deflection, resulting from the greater of the uniform live load of the adjacent floor or a live load of 100 psf, to 1/4 inch or the span divided by 240, whichever is less.
- C. Cover plate fastening devices and hardware shall be Type 316 Stainless Steel.
- D. Checkered plate shall have a Mill Finish.

2.09 IRON CASTINGS

- A. Iron castings shall be of uniform quality, free from blowholes, porosity, hard spots, shrinkage, distortion, or other defects. They shall be smooth and well cleaned by shot blasting.
- B. Covers and grates shall fit together evenly, so that the cover fits flush with the surrounding finish surface and so that the cover does not rock or rattle when loading is applied. Round covers and frames shall have machined bearing surfaces.
- C. Covers and grates with matching frames shall be designed to support the following loadings:
 - 1. Where located within a structure, the design loading shall match that required for the adjacent floor area, or, if no loading is given, a minimum of 300 psf, unless indicated otherwise.
 - 2. Exterior covers and grates shall be designed for AASHTO HL93 (HS20) loading unless indicated otherwise.

2.10 STEEL PROTECTION POSTS (BOLLARDS)

- A. Provide 4-inch diameter, Schedule 40 steel pipe, 4 feet above grade, 3 feet 6 inches below grade, unless otherwise noted on the Drawings.

2.11 BOLTS AND ANCHORS

- A. Standard Service (Non-Corrosive Application): Unless otherwise indicated, bolts, anchor bolts, washers, and nuts shall be steel, galvanized after fabrication as indicated herein. Threads on galvanized bolts and nuts shall be formed with suitable taps and dies such that they retain their normal clearance after hot-dip galvanizing. Except as otherwise indicated, steel for bolts, anchor bolts, and cap screws shall be in accordance with the requirements of ASTM A307, Grade A.
- B. Corrosive Service: All anchor bolts, bolts, nuts, and washers in the locations listed below shall be stainless steel as indicated below.
 - 1. All buried locations
 - 2. All submerged locations
 - 3. All locations subject to seasonal or occasional flooding
 - 4. Inside hydraulic structures below the top of the structure
 - 5. Inside buried vaults, manholes, and structures that do not drain through a gravity sewer or to a sump with a pump
 - 6. All chemical handling areas
 - 7. Inside trenches, containment walls, and curbed areas
 - 8. Locations indicated on the Drawings or designated by the Engineer to be provided with stainless steel bolts or anchors
- C. All bolted connections for aluminum members shall be stainless steel.
- D. Unless otherwise indicated, stainless steel bolts, anchor bolts, nuts, and washers shall be Type 316 stainless steel, class 2, conforming to ASTM A276. All threads on stainless steel bolts shall be protected with an antiseize lubricant suitable for submerged stainless-steel bolts, to meet government specification MIL-A-907E. Buried bolts in poorly drained soil shall be coated the same as the buried pipe.
 - 1. Antiseize lubricant shall be classified as acceptable for potable water use by NSF.
 - 2. Antiseize lubricant shall be "PURE WHITE" by Anti-Seize Technology, or equal.
- E. Bolt Requirements:
 - 1. The bolt and nut material shall be free-cutting steel.
 - 2. The nuts shall be capable of developing the full strength of the bolts. Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads. All bolts and cap screws shall have hexagon heads and nuts shall be Heavy Hexagon Series.
 - 3. All bolts and nuts shall be installed with washers fabricated of material matching the base material of bolts, except that hardened washers for high strength bolts shall conform to the requirements of the AISC Specification. Lock washers shall be installed with washers where indicated and shall be fabricated of material matching the bolts.
 - 4. The length of all bolts shall be such that after joints are made up, each bolt shall extend through the entire nut, but in no case more than 1/2 inch beyond the nut.

- F. Cast-in-Place Anchor Rods – Unless otherwise indicated, the embedded end of the anchor rod shall be either headed or with nut and washer. Threaded dimensions for cast-in headed studs and/or headed rods, before zinc coating, shall conform to the requirements of ANSI/ASME B1.1 having Class 2A tolerances (ANSI/ASME Standard B1.13M Grade 6g). Use of hooked bolts (J-bolts and L-bolts) in lieu of headed studs/rods is not permissible.
1. Equipment subject to vibration (e.g., pumps, motors, generators, etc.) shall be anchored by means of cast-in-place anchor rods. Anchor rod layout shall be by means of a template obtained from the equipment manufacturer or supplier.
- G. Post-Installed Adhesive Anchors – Unless otherwise indicated, all post-installed adhesive anchors for installation in concrete shall have satisfied the requirements of the Simulated Seismic Tests of ACI 355.4. No substitutions will be considered unless accompanied with ICC-ES report verifying strength and material equivalency and compliance with ACI 355.4.
1. The design and installation of adhesive anchors in concrete shall comply with ACI 318 Chapter 17. The characteristic bond stresses, ϕ_{cr} and ϕ_{uncr} , shall be based on long term elevated temperatures of not less than 110 degrees Fahrenheit.
 2. Post-installed adhesive anchors shall be Hilti HIT-HY 200 adhesive anchors, Powers Pure110+ adhesive anchors, or equal.
 3. Post-installed adhesive anchors shall not be used for overhead installations (i.e., installations at the underside of concrete slabs).
- H. Post-Installed Expansion (Torque-Controlled and Displacement-Controlled) and Undercut Anchors - Unless otherwise indicated, all post-installed expansion and/or undercut anchors for installation in concrete shall have satisfied the requirements of the Simulated Seismic Tests of ACI 355.2. Post-installed expansion anchors shall be zinc-plated carbon steel wedge-type anchors complete with nuts and washers. Type 316 stainless steel wedge type anchors shall be used where they will be submerged or exposed to the weather or where stainless-steel wedge type anchors are required. When the length or embedment of the bolt is not noted on the Drawings, provide length sufficient to place the wedge and expansion sleeve portion of the bolt at least 1 inch behind the concrete reinforcing steel.
1. The design and installation of expansion anchors and undercut anchors in concrete shall comply with ACI 318 Chapter 17.
 2. Post-installed expansion anchors shall be Hilti Kwik Bolt TZ anchors, Simpson Strong-Tie Strong-Bolt 2 Wedge Anchors, or equal.
- I. Shell and lead caulking anchors will not be permitted.
- J. Post-installed expansion and adhesive anchors shall not be used with equipment subject to vibration (e.g., pumps, motors, etc.).

2.12 POWDER DRIVEN PINS

- A. Powder-driven pins for installation in concrete or steel shall be heat-treated steel alloy. If the pins are not inherently sufficiently corrosion-resistant for the conditions to which they are to be exposed, they shall be protected in a manner acceptable to the Engineer. Pins shall have capped or threaded heads capable of transmitting the loads the shanks are required to support. Pins that are connected to steel shall have longitudinal serrations around the circumference of the shank.

2.13 IMPACT ANCHOR

- A. Impact anchors shall be expansion-type anchors in which a nail-type pin is driven to produce the expansive force. It shall have a zinc sleeve with a mushroom-style head and stainless-steel nail pin. Anchors shall be Metal Hit Anchors, as manufactured by Hilti, Inc.; Zamac Nailin, as manufactured by the Powers Fasteners; or equal.

PART 3 - EXECUTION

3.01 FABRICATION AND INSTALLATION REQUIREMENTS

- A. Fabrication and Erection: Except as otherwise indicated, the fabrication and erection of structural steel shall conform to the requirements of the AISC "Steel Construction Manual."
- B. All steel surfaces that come into contact with exposed concrete shall receive a protective coating of an approved heavy bitumastic troweling mastic applied in accordance with the manufacturer's instructions before installation.
- C. Where aluminum contacts a dissimilar metal, apply a heavy brush coat of zinc-chromate primer followed by two coats of aluminum metal and masonry paint to the dissimilar metal.
- D. All aluminum surfaces in contact with concrete or masonry shall receive a coating in accordance with Section 09 90 00 before the placement of concrete or masonry.
- E. Aluminum Components:
 - 1. Electrolysis protection of materials shall be provided.
 - 2. Between aluminum grating, aluminum tread plate, aluminum stair treads, or aluminum handrail brackets and steel supports, insert 1/4-inch-thick neoprene isolator pads, 85 plus or minus 5 Shore-A-Durometer, sized for full width and length of bracket or support.
- F. Floor Hatches: Unless otherwise shown, the Contractor shall furnish and install a 1-1/2-inch drain line to the nearest floor drain for all floor hatches.
- G. Powder-Driven Pins: Powder-driven pins shall be installed by a craftsman who is certified by the manufacturer as being qualified to install the manufacturer's pins. Pins shall be driven in one initial movement by an instantaneous force that has been carefully selected to attain the required penetration. Driven pins shall conform to the following requirements where "D" = Pin's shank diameter:

Material Penetrated by Pin	Material's Minimum Thickness	Pin's Shank Penetration in Supporting Material	Minimum Space from Pin's CL to Edge of Penetrated Material	Minimum Pin Spacing
Concrete	16D	6D Minimum	14D	20D
Steel	1/4 inch	Steel Thickness	4D	7D

3.02 WELDING

- A. Method - All welding shall be by the metal-arc method or gas-shielded arc method as described in the AWS's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards governing same.

- B. Welding electrodes shall meet the minimum requirements of E70XX. Filler metal for welds in moment connections shall have a minimum CVN value of 20 foot-pounds at 0 degrees Fahrenheit.
- C. Quality - In assembly and during welding, the component parts shall be adequately clamped, supported and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as indicated by the AWS Code. Upon completion of welding, all weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance, with uniform weld contours and dimensions. All sharp corners of material to be painted or coated shall be ground to a minimum of 1/32 inch on the flat.

3.03 GALVANIZING

- A. All structural steel plates shapes, bars, and fabricated assemblies required to be galvanized shall, after the steel has been thoroughly cleaned of rust and scale, be galvanized in accordance with the requirements of ASTM A123. The galvanizing process shall be performed in strict accordance with the requirements of ASTM A384. Any galvanized part(s) that become warped as a result of the galvanizing process and/or handling shall be straightened or replaced at no additional expense to the District.
- B. Bolts, anchor bolts, nuts, and similar threaded fasteners, after being properly cleaned, shall be galvanized in accordance with the requirements of ASTM A153.
- C. Repair of Damaged Coating:
 - 1. The maximum area that shall be repaired shall comply with applicable sections of ASTM A123.
 - 2. Repair areas by one of the approved methods in accordance with ASTM A780 whenever damage width exceeds 3/16 inch. Minimum thickness requirements for the repair shall be as described in ASTM A123.
 - 3. Field repairs to galvanizing shall be made by the application of a minimum of two coats of a cold galvanizing zinc compound such as Galvite, or equal.

3.04 POST-INSTALLED CONCRETE ANCHORS

- A. Post-installed concrete anchors and reinforcing bars (dowels) shall be installed in strict accordance with the Manufacturer's Printed Installation Instructions (MPII).
- B. Holes shall be roughened with a brush on a power drill, cleaned, and dry.
- C. Expansion anchors shall not be installed until the concrete has reached the specified 28-day compressive strength.
- D. Adhesive anchors and dowels shall not be installed until the concrete has a minimum age of 21 days and has reached the specified 28-day compressive strength.
- E. Adhesive anchors and dowels installed in a horizontal or upwardly inclined position shall have the following additional requirements:
 - 1. Installation shall be performed by personnel certified in accordance with the ACI/CRSI Adhesive Anchor Certification program.
 - 2. Installation shall be inspected by a certified special inspector who is continuously present when the installation is performed.
- F. Post-installed adhesive anchors shall not be loaded until the adhesive has reached its indicated strength in accordance with the manufacturer's instructions.

- G. Post-installed mechanical anchors shall be checked for tightness a minimum of 24 hours after initial installation. Install anchors using the manufacturer's recommended drive units and adapters, in compliance with the manufacturer's recommendations.

END OF SECTION

SECTION 05 51 00

METAL STAIRS

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals necessary and install aluminum metal stairs and platforms complete with anchors and brackets, including ladders, integral handrails and posts when applicable, as shown on the Drawings and as specified herein.

1.02 RELATED SECTIONS

- A. Section 01 61 20 – Seismic Design Criteria
- B. Section 03 30 00 – Cast-in-Place Concrete
- C. Section 05 50 00 – Metal Fabrications
- D. Section 05 52 00 – Metal Railings
- E. Section 09 90 00 – Painting and Coating

1.03 SUBMITTALS

- A. Submit to the Engineer, in accordance with Division 1, shop drawings and product data showing materials of construction and details of installation for the following.
 - 1. Submit manufacturer's shop drawings, showing dimensions, material lists, methods of supporting, methods of anchoring, and finishes.
 - 2. Submit product data for manufacturer's product lines of shop-fabricated aluminum stairs assembled from standard components. Submit product data for grout, anchoring cement, and paint products.
 - 3. Submit shop drawings showing fabrication and installation of platforms and shop-fabricated metal stairs including plans, elevations, sections, details of components, and attachments to other units of Work.
 - 4. Submit samples for verification of each type of exposed finish required, prepared on components of same thickness and metal indicated for final unit of Work. Where finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.
 - 5. Submit qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
 - 6. Furnish to the Engineer a letter signed and sealed by a Professional Civil or Structural Engineer licensed in the State of California that the stair design as shown on the shop drawings conforms to the design criteria set forth by governing Codes, Standards, and this Section. Alternatively, stair drawings shall be signed and sealed by a Professional Civil or Structural Engineer licensed in the State of California.
 - 7. Submit calculations and data showing the location, magnitude, and direction of all dead, live, wind, and seismic load reactions imposed on the structure by the stair and railing system. Calculations shall be signed and sealed by a Professional Civil or Structural Engineer licensed in the State of California.

8. Submit structural calculations for the platforms (including railing and anchorage) subjected to dead, live, and seismic loads. Calculations shall be signed and sealed by a Professional Civil or Structural Engineer licensed in the State of California.
9. Submit stair manufacturer's certification that materials meet specification requirements.

1.04 REFERENCE STANDARDS

- A. Aluminum Association (AA)
 1. Aluminum Design Manual
 2. Specification for Aluminum Structures
 3. AA 6061-T6 – Aluminum Sheet and Plates
- B. American Institute for Steel Construction (AISC)
 1. ANSI/AISC 360 – Specification for Structural Steel Buildings
- C. American Society of Civil Engineers (ASCE)
 1. ASCE/SEI 7, Minimum Design Loads for Buildings and Other Structures
- D. American Welding Society (AWS)
 1. ANSI/AWS D1.1 – Structural Welding Code - Steel
 2. ANSI/AWS D1.2 – Structural Welding Code - Aluminum
 3. ANSI/AWS QC1 – Qualification and Certification of Welding Inspectors
- E. ASTM International (ASTM)
 1. ASTM B221 – Standard Specification for Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
 2. ASTM E985 – Standard Specification for Permanent Metal Railing Systems and Rails for Buildings
- F. California Building Standards Commission (CBSC)
 1. California Building Code (CBC)
- G. National Association of Architectural Metal Manufacturers (NAAMM)
 1. NAAMM AMP 510 – Metal Stairs Manual
 2. NAAMM MBG 531 – Metal Bar Grating Manual
- H. Occupational Safety and Health Standards (OSHA)
 1. Code of Federal Regulations, 29 CFR, Part 1910
- I. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 PERFORMANCE REQUIREMENTS

- A. General – Platforms and shop-fabricated aluminum stairs shall be designed to withstand structural loads indicated. Determine allowable design working stresses based on Aluminum Association (AA) "Specification for Aluminum Structures".
- B. Structural Performance of Shop-Fabricated Aluminum Stairs: Engineer, fabricate, and install to comply with requirements of ASTM E985 for structural performance based on structural computations.

- C. Thermal Movements – Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in engineering, fabricating, and installation to prevent buckling, opening of joints, overstressing of components and connections, and other detrimental effects. Engineering calculations shall be based on the actual surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.
- D. Temperature Change (Range): Allowance for thermal movement shall be based on a temperature change of plus or minus 90 degrees Fahrenheit from the average ambient temperature at the project site, or from the temperature at time of installation, whichever is more stringent.
- E. Control of Corrosion – Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.06 QUALITY ASSURANCE

- A. Single-Source Responsibility – Obtain shop-fabricated aluminum stairs from a single manufacturer.
- B. Engineer Qualifications – The Engineer shall be a Professional Civil or Structural Engineer licensed in the State of California and experienced in providing engineering services of the kind indicated that have resulted in the installation of similar stairs to this Project in material, design, and extent and that have a record of successful in-service performance.
- C. Industry Standards - Comply with the provisions of the following standards and specifications:
 - 1. ANSI/AISC 360
 - 2. NAAMM – AMP-510
 - 3. NAAMM – MBG 531
 - 4. ANSI/AWS–D1.2

1.07 DELIVERY, STORAGE, AND HANDLING

- A. All materials shall be delivered promptly so as to cause no delay with other parts of the work. Stored materials shall be placed on skids and not on the ground and shall be piled and blocked up so that they will not become bent or otherwise damaged. Materials shall be stored inside a well-ventilated area, away from uncured concrete and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity. Materials shall be handled with cranes or derricks as far as practicable. Material shall not be dumped off cars or trucks nor handled in any other way likely to cause damage. Materials with excessive damage, in the opinion of the Engineer, shall not be incorporated in the work and shall be removed and replaced, at the Contractor's expense, with new undamaged materials, to the satisfaction of the Engineer.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. All like materials shall be the products of one manufacturer or supplier in order to provide standardization of appearance.

2.02 MATERIALS

- A. Aluminum: ASTM B221, Alloy 6061-T6, Finish AA-C22A31.

- B. Components:
1. Stringers – Aluminum
 2. Headers – Aluminum
 3. Treads – Aluminum
 4. Risers – Aluminum
 5. Platforms – Aluminum
 6. Railings – Aluminum
 7. Ladders – Aluminum
 8. Fasteners and anchors – Type 316 stainless steel

2.03 GENERAL FABRICATION

- A. Size members as required by design calculations and to conform to layout details shown. Detail platforms, stair risers, treads, and landings to conform to the requirements of the current edition of OSHA and the California Building Code. Detail handrails and guardrails to conform to the requirements of Section 05 52 00.
- B. Fabricate platforms, stairs, landings and component connections to support a minimum live load of 100 pounds per square foot with deflection of platforms, stairs and landings not to exceed L/360. Stairs exceeding vertical height of 12 feet shall have intermediate landings.
- C. Fabricate railing supports and component connections capable of resisting a lateral force of 200 pounds at any single point or 50 pounds per lineal foot as required by Code, without permanent set or damage. Where railing is mounted to the top of the stair stringer flange or other support beam, the stair stringer or support beam shall have a minimum width of 2.5 inches. Welding of railing to the stringers or beams shall not be acceptable unless the stair design includes the effects of welding on the design strength of the members.
- D. For seismic design requirements, see Section 01 61 20. The seismic importance factor for stair design shall be $I_p = 1.5$.
- E. Unless otherwise directed by the Engineer or shown on the Drawings, fabricate stairs with closed risers and closed treads using structural aluminum channels, angles, plates, and extrusions for stringers, treads and all supports. Provide closures for exposed ends of stringers.
- F. Fabricate treads from extruded/cast structural aluminum grating with integral nosing to form a one-piece structural unit.
- G. Fabricate landings from extruded/cast structural aluminum grating with integral nosing to form a one-piece structural unit. Construct with perimeter structural aluminum channels as shown, side-supported headers and miscellaneous framing members framing into the stair stringers. Reinforce underside of landings.
- H. Construct stairs to conform to sizes and arrangements indicated; join pieces together by welding wherever possible. Weld assemblies in accordance with recommendations of AWS. Grind all exposed welds to a match and blend with adjoining surfaces.
- I. Provide complete stair assemblies including framing, columns, railings, struts, clips, brackets, bearing plates, and all other components necessary for the support of stairs and landings and as required to anchor and contain the stairs on the supporting structure.
- J. Provide aluminum grating and ladders at platforms. Provide minimum 6 inches clear between platform framing (columns, beams, bracing) and piping. Coordinate platform

column locations and base plate detailing with existing construction (including the Control Building pipe gallery longitudinal drainage trench).

- K. Shop-assemble sections in largest sizes practical, easily maneuverable through building openings.
- L. Form work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to radius of approximately 1/32 inch. Form bent metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

PART 3 - EXECUTION

3.01 ERECTION

- A. Erect stairs and platforms square, level, plumb, and free from distortion or defects detrimental to appearance and performance.
- B. Provide necessary anchors, plates, angles, hangers, and struts as required for connecting stairs and platforms to the structure.
- C. Ensure alignment with adjacent construction. Coordinate with related work to ensure no interruption in installation.
- D. Perform necessary cutting and altering for the installation of work of other Sections. Do not perform any other additional cutting without prior review and approval of the Engineer. If approved, cutting and/or altering of stair elements shall be done in an approved manner to the satisfaction of the Engineer.
- E. Field bolt and weld to match standard of shop bolting and welding. Hide bolts and screws whenever possible. Where not hidden, use flush countersunk fastenings, unless indicated otherwise. Make mechanically fastened joints flush hairline-buttet. Grind welds smooth and flush.

3.02 PROTECTION

- A. Protect aluminum fabrications from damage due to work of adjacent trades.

3.03 CLEANING

- A. As work progresses, remove debris, and leave installation sites broom clean.
- B. Before final acceptance, clean stairs of any paint, mud, or other adherents.

END OF SECTION

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SECTION 05 52 00

METAL RAILINGS

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Section Includes:
 - 1. Aluminum mechanically fastened tube handrails, guardrails, railings, pickets, brackets, anchor plates, inserts, fasteners and accessories as indicated.

1.02 RELATED SECTIONS

- A. Section 05 50 00 – Metal Fabrications
- B. Section 05 51 00 – Metal Stairs
- C. Section 09 90 00 – Painting and Coating

1.03 COORDINATION

- A. Coordinate installation of anchorages for handrails, guardrails, and railings. Furnish setting drawings, templates, and directions for installing anchorages, including backers, fillers, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or built into framed walls. Deliver such items to Project site in time for installation.
- B. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

1.04 SUBMITTALS

- A. Product Data: Provide product data for fittings, railing brackets, piping, inserts and installation accessories.
- B. Shop Drawings: Provide plans, elevations, sections, details showing attachments to other work.
 - 1. Shop Drawings shall show all electrical, plumbing and other penetrations furnished by other trades at concrete slabs in vicinity of guardrails.
- C. Samples:
 - 1. Provide sample of railing at top rail and post intersection with typical mechanical connection in specified finish.
 - 2. Provide typical fittings and brackets.
- D. Deferred-Design Submittal: For guardrails and hand rails, submit structural calculations signed and sealed by the qualified California professional engineer responsible for their preparation.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

1.06 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers for aluminum pipes, pipe fittings, reinforcements, brackets, and related components:
 - 1. Hollaender Manufacturing Company, Interna-Rail Mechanical Handrail System
 - 2. The Wagner Company, Intern-Rail Non-Welded Pipe Railing System.
 - 3. Or equal.
- B. Source Limitations: Obtain each type of railing, fittings, fasteners and accessories from single source from single manufacturer.

2.02 PRODUCTS

- A. Pipe handrails railings and pickets shall be mechanically fastened, flush-fit, internal aluminum system. Fittings shall be externally connected to the pipe by means of an anodized aluminum, tubular rivet nut, and an austenitic 302 alloy stainless steel, socket head cap screw with a stainless-steel lock washer. The fitting shall be internally connected to the pipe by means of an internal double tang, expanded by an austenitic 302 alloy stainless steel, internal / external, reverse knurl, cup point, hexagon socket set screw. Pop rivets, sheet metal screws, and adhesives shall not be an acceptable fastening method. The fittings shall be machined of solid aluminum bar stock of alloy 6063-T6 conforming to ASTM B221, or machined castings of high-tensile aluminum-magnesium alloy 535.0 manufactured in compliance with ASTM B26, cast from high-purity ingot 535.2 conforming to ASTM B179. Flanges (if required) shall be sand cast from high-tensile aluminum magnesium alloy 535.0 and fastened directly to the pipe by means of an internal / external, reverse knurl, cup point, hexagon socket set screw (flanges which include a bearing plate will not be accepted). Aluminum fittings with an anodized finish shall match aluminum railing system.

2.03 PERFORMANCE REQUIREMENTS

- A. Deferred Design: Contractor shall employ a qualified California professional engineer, to design guardrails and handrails, including attachment to building construction. Coordinate with metal stair structural engineer for mounting where occurs.
- B. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf / ft. applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

2.04 ALUMINUM HANDRAILS AND RAILINGS

- A. Aluminum, General: Provide alloy and temper recommended by manufacturer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.
- B. Extruded Structural Pipe and Round Tubing: ASTM B221, Alloy 6063-T6.
- C. Extruded Bars and Tubing: ASTM B221, Alloy 6063-T5/T52, 6005-T5 Provide 1-1/2 in IPS, (1.90 in OD) Standard Weight (Schedule 40) pipe for rails, Schedule 80 for posts, Schedule 10 for pickets, unless otherwise indicated.
- D. Toe Board: As indicated.
- E. Cast-In-Place Sleeves: As Indicated.

2.05 FASTENERS

- A. General: Provide the following:
 - 1. Aluminum Railings: Type 304 Stainless Steel.
- B. Fasteners for Anchoring Railings to Other Construction: Manufacturer's standard select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads. Fasteners shall be determined by deferred design engineer's calculations.
- C. Fasteners for Interconnecting Railing Components: Rails shall be attached to posts by means of tee fittings equipped with anodized aluminum, tubular rivet nut and stainless steel socket head cap screw. All structural fasteners such as tee fittings shall be machined from 6063-T6 aluminum alloy. The fitting shall be internally connected to the rail by means of an internal dual tang that is expanded with a stainless steel, internal /external, reverse knurl, cup point socket head set screw. This combination shall prevent any loosening of the system due to changes in temperature or vibration. Systems using pop rivets or adhesives will not be accepted.

2.06 MISCELLANEOUS MATERIALS

- A. Cast-In-Place Sleeves: As indicated.
- B. Setting grout, bituminous paint and sealants as recommended by railing manufacturer.

2.07 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
- B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas to exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that are exposed to weather in a manner that excludes water. Provide weep holes where water may accumulate.

- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with mechanical connections unless otherwise indicated.
- H. Mechanical Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose.
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
- I. Form changes in direction as detailed.
- J. Close exposed ends of railing members with prefabricated end fittings, unless otherwise shown.
- K. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns.
- L. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
 - 1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.
- M. Provide inserts and other anchorage devices for connecting railings to concrete. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.
- N. Toe Boards: Where indicated, provide toe boards at railings around opening and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.08 ALUMINUM FINISHES

- A. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- B. All handrails, railings, pickets, and related components shall be AA-M12C2XA44, Class I, Dark Bronze Anodized Finish, 0.7 mils minimum thickness.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine all assemblies, where reinforced to receive anchors, to verify that locations concealed reinforcements are clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.02 INSTALLATION, GENERAL

- A. Fit exposed connection together to form tight, hairline joints.
- B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of risk.

1. Do cut or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
 3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.
- C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
1. Coat concealed surfaces of aluminum that are in contact with concrete or dissimilar metals in accordance with Section 09 90 00, Painting and Coating.
- D. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- E. Fastening in In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.
- 3.03 RAILING CONNECTIONS
- A. Provide connections as indicated on the Drawings, if not indicated as designed by the manufacturer's engineer.
- 3.04 ANCHORING POSTS
- A. Anchor posts to substrates as indicated on the Drawings, if not indicated as designed by the manufacturer's engineer.
- 3.05 ATTACHING RAILINGS
- A. Secure wall brackets and railing end flanges to structure as indicated on the Drawings, if not indicated as designed by the manufacturer's engineer.
- 3.06 ADJUSTING AND CLEANING
- A. Clean aluminum stainless steel by washing thoroughly with clean water and soap and rinsing with clean water.
- 3.07 PROTECTION
- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings prior to completion.

END OF SECTION

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SECTION 06 60 00

FIBERGLASS REINFORCED PLASTIC FABRICATIONS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Fiberglass reinforced plastic (FRP) channels, stairs, platforms, guardrail, handrails, grating, plate, and structural support systems for stairs, landings, platforms, and miscellaneous work as shown on the Drawings and specified herein.

1.02 RELATED SECTIONS:

- A. Section 01 61 20 – Seismic Design Criteria
- B. Section 01 61 40 – Wind Design Criteria

1.03 REFERENCES

- A. American Society for Testing and Material (ASTM):
 - 1. ASTM D349 – Standard Test Method for Laminated Round Rods Used for Electrical Insulation.
 - 2. ASTM D638 – Standard Test Methods for Tensile Properties of Plastic.
 - 3. ASTM D790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics Electrical Insulating Materials.
 - 4. ASTM D792 – Standard Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement.
 - 5. ASTM D2344 – Standard Test Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates
 - 6. ASTM D696 – Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30°C and 30°C with a Vitreous Silica Dilatometer
 - 7. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials
- B. American Society of Civil Engineers (ASCE)
 - 1. ASCE 7-6 – Minimum Design Loads and Associated Criteria for Buildings and Other Structures.
- C. California Building Code (CBC)
- D. Occupational Safety and Health Administration (OSHA).
- E. NSF International
 - 1. ANSI/NSF 61 – Drinking Water System Components
- F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 SUBMITTALS

- A. Submit product data for FRP manufactured systems and fully describe all products proposed for use. Include data on physical, chemical, and structural properties.
- B. Shop Drawings: Submit complete detailed shop drawings showing materials, properties and details of fabrication, construction and installation.

- C. Calculations: The manufacturer shall design stairs, platforms, landings, grating, ladders, plate, and guardrails for the loads specified herein and, in the California, Building Code. Complete design calculations signed and sealed by a professional civil or structural engineer registered in the State of California shall be submitted for record purposes prior to the delivery of such items.
- D. Samples: Submit two sets of samples of grating, plate, ladder rung, ladder side rail and typical framing members for review by the Engineer in representative sizes and types. Samples shall be representative of construction, workmanship, appearance and surface finish of the manufactured items which are proposed. Samples shall be from plant production.
- E. Quality Control: Submit certified test data based on tests of actual production samples which demonstrate that the products conform to the stress and deflection requirements specified herein.

1.05 QUALITY CONTROL

- A. The fiberglass reinforced plastic components manufacturer shall have a minimum of 5 years experience in the manufacturing of items of similar size, use, and quality and shall submit a list of successful installations involving the items under similar conditions to this project.
- B. The work of this Section shall be completely coordinated with the work of other Sections. Verify at the site both the dimensions and work of other trades adjoining items of work in this Section before fabrication and installation of items specified.
- C. Furnish to the pertinent trades all items included under this Section that are to be built into the work of other Sections.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Resin for FRP fabrications shall be a premium performance vinyl ester with a tested flame spread rating of 25 or less per ASTM E84 Tunnel Test (except NSF 61 certified resin), integrally resistant without applied coatings to ultra-violet radiation.
 - 1. All FRP products used shall be suitable for intermittent exposure to the chemical used in the particular area.
 - 2. Provide compatible and equally resistant resin for shop and field sealing of cut edges.
 - 3. All finished surfaces of FRP items and fabrications shall be smooth, resin-rich, free of voids and without dry spots, cracks, crazes or unreinforced areas. All glass fibers shall be well covered with resin to protect against their exposure due to wear or weathering.
 - 4. FRP fabrications shall have integral colors acceptable to the Engineer selected from standard resin colors. Unless revised by the Engineer in the submittal process, the following colors shall be provided:
 - a. Guardrails, handrails, and ladders: light yellow.
 - b. Gratings: match existing color where new Work joins existing, otherwise light yellow.
 - c. Other FRP components: match existing color where new Work joins existing, otherwise light green.
 - 5. All FRP products located outdoors or outdoors under canopies shall be protected from ultraviolet (UV) attack with integral UV inhibitors in the resin, a synthetic

surfacing veil to help produce a resin rich surface, and a UV resistant polyurethane coating.

6. Fasteners and components – Stainless steel Type 304 or 316. Type 316 for submerged applications.

B. FRP Shapes and Plates

1. Minimum physical properties for pultruded structural FRP shapes and plates shall be as follows:
 - a. Tensile Strength (coupon) 206,200 kN/sq. m (30,000 psi) - ASTM D638
 - b. Tensile Strength (full section in bending) 137,800 kN/sq.m at 24 degrees C (20,000 psi at 75 degrees F)
 - c. Modulus of Elasticity 1.58 x 10⁷ kN/sq.m at 24 deg. C (2.3 x 10⁶ psi at 75 degrees F) 1.24 x 10⁷ kN/sq.m at 52 deg. C (1.8 x 10⁶ psi at 125 degrees F) - ASTM D790
 - d. Short Beam Shear 31,000 kN/sq. m (4,500 psi) - ASTM D2344
 - e. Coefficient of Thermal Expansion 1.4x10⁻⁶ cm/cm/°C (8.0x10⁻⁶ in/in/°F)
 - f. Barcol Hardness - 45
 - g. Water Absorption - 0.75 percent (by weight) - ASTM D349
 - h. Specific Gravity - 1.66 - ASTM D792
2. Structural shapes shall be pultruded FRP utilizing a vinyl ester resin system with an integral ultraviolet light inhibitor. Pultruded FRP shall be as manufactured by Strongwell Fiberglass, Bristol, VA, Dynaform by Fibergrate Corp., Dallas, TX, or Pultex by Creative Pultrusions, Alum Bank, PA, or equal.

C. FRP Grating and Grating Platform

1. FRP grating shall be Fibergrate Corp., Dallas, Texas, Chemgrate Corp., Woodinville, WA, or equal. The FRP fabricator shall design the grating for the required spans using criteria herein.
2. Outer surfaces, cut edges, or any surfaces which are exposed to air during cure shall be finished so as to obtain complete cure of the resin without air inhibition by coating the surface after initial cure with resin containing paraffin. Softening or tackiness of any surface under an acetone test will be considered evidence of incomplete cure.
3. Factor of safety shall be 5 based on ultimate stress. Unless otherwise noted, grating shall be a minimum of one and one-half (1.5) inches deep and have a rectangular bar shape.
4. Grating shall be constructed of bi-directional bearing bars composed of glass fiber and resin, compression molded at high temperatures and pressure. Glass content of the grating shall be a minimum of 25 percent and a maximum of 35 percent by weight as determined by ASTM D2584. No dry glass fibers shall be visible on any surface of bearing bars. Top surfaces shall have a concave or integral grit surface for skid resistance.
5. The FRP grating shall meet the following loading requirements. In addition to the dead load of the grating, the grating shall be capable of supporting a uniform live load of 100 psf while maintaining a deflection of less than 1/4-in or L/200 whichever is smaller. Grating shall also be capable of supporting a concentrated live load of 600 lb/ft transverse to the span.
6. Provide structural FRP angle frames and structural support shapes, where required and appurtenances as shown.

7. Provide a complete platform support system including, but not limited to FRP angle frames, beams, and columns.
8. Angle frames shall be continuous around the opening in order to present an even and flat support for the grating except as otherwise shown. The angles and anchors shall be as detailed.
9. FRP grating shall be securely attached to supporting members and angles. Attachment to FRP supporting members shall be by stainless steel fasteners. Each grating panel shall be attached to supporting members at a minimum of four locations (two each edge). All materials and incidentals required for attaching grating to angle frame and supports shall be furnished and installed under this Section. Grating anchorage shall be fully removable and installable from the top surface.
10. Coordinate the layout of grating panels with work of other Sections to provide openings for approved mechanical equipment, operators, and other items which require penetrations or openings in the grating. Grating panels shall be further subdivided and supported to provide maximum panel weight of 50 pounds.

D. Guardrailing

1. FRP guardrailing shall be manufactured by Fibergrate Corp, Dallas, TX; SAFRAIL, by Strongwell Fiberglass, Bristol, VA; or equal. The guardrailing system shall be designed to withstand a 200 lb load applied at any point, in any direction to the top rail with a maximum deflection of 1/2-in and a uniform load of 50 lb/ft with the same deflection criteria. Uniform and point load need not be applied simultaneously. Railing systems shall comply with all requirements of the California Building Code.
2. Guardrailing shall be a three-rail system composed of either 1-3/4 or 2 inches square FRP tubes; solid FRP connector plugs snugly fitting the inside dimensions of tubes; solid 1/2-inch diameter FRP connector rods; and 1/8-inch thick, 4-inch high, FRP kickplates. Provide FRP sleeves for removable connections to concrete and provide FRP baseplate assemblies with stainless steel fasteners for wall connections and for slab connections where shown. Provide approved epoxy cement for all tube, plug and rod connections and epoxy grout for post connections set in concrete. Systems utilizing rails riveted to posts shall use 18-8 stainless steel rivets.
3. Fabricate with continuous posts and top rail, with intermediate rails cut between posts. Miter corners and direction changes neatly. Provide for rail expansion as required with internal plugs cemented one side and square, resin sealed, tube ends. Provide for kickplate expansion where required.
4. Post-installed anchors shall be adhesive or expansion type anchors. Post-installed anchors, when used, shall have current ICC Evaluation Service Reports. Adhesive anchors shall be Hilti HIT-RE 500 V3 system by Hilti, Inc., Tulsa, OK; Simpson SET-XP Epoxy Adhesive Anchors by Simpson Strong-Tie Company, Inc., Pleasanton, CA; or equal. Expansion anchors shall be Hilti Kwuk-Bolt TZ by Hilti, Inc., Tulsa, OK; Simpson Strong-Bolt 2 Wedge Anchor by Simpson Strong-Tie Company, Inc., Pleasanton, CA; or equal. Provide miscellaneous bolts, nuts and washers as required. Size as shown or required by calculations completed by fabricator. Provide all fastener components in Type 304 or Type 316 stainless steel.

PART 3 - EXECUTION

3.01 DESIGN AND INSTALLATION

- A. The FRP fabricator shall design the FRP products and systems as shown on the Drawings or specified herein. All components shall be installed in full accordance with the Drawings, the final approved shop drawings and the manufacturer's recommendations. Components shall be secure, plumb, and level.
- B. Guardrail and handrail components shall be free of burrs and sharp edges.
- C. Replace any elements with damaged coatings or exposed fibers.

END OF SECTION

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SECTION 09 90 00 - PAINTING AND COATING**PART 1 - GENERAL****1.1 SUMMARY**

- A. Section Includes: Surface preparation and field application of paints, including pretreatment, coating application, touch-up of factory-coated surfaces, protection of surfaces not to be coated, cleanup and other coatings.
- B. Glass, stainless steel, and equipment nameplates shall not be protective coated unless shown otherwise on the Drawings.

1.2 DEFINITIONS

- A. Refer to ASTM D16 for definitions of terms used in this Section.
- B. The term "paint," "coatings," "linings," or "finishes" as used herein, shall include surface treatments, emulsions, enamels, paints, epoxy resins, and all other protective coatings, excepting galvanizing or anodizing, whether used as a pretreatment, primer, intermediate coat, or finish coat. The term "DFT" means minimum dry film thickness.

1.3 REFERENCE STANDARDS

- A. ASTM International:
 - 1. ASTM C309 – Standard for Liquid Membrane – Forming Compounds for Curing Concrete.
 - 2. ASTM D16 – Standard Terminology for Paint, Related Coatings, Materials, and Applications.
 - 3. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials.
 - 4. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- B. AWWA
 - 1. AWWA C105 – Standard for Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids.
 - 2. AWWA C205 - Standard for Cement-Mortar Protective lining and Coating for Steel Water Pipe – 4-inch and larger – Shop applied.
 - 3. AWWA C550 - Standard for Protective Epoxy Interior coatings for Valves and Hydrants.

- C. California Department of Public Health:
 - 1. CA/DHS/EHLB/R-174 - Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda.
- D. Caltrans Standard Specifications
 - 1. Section 59 – Structural Steel Coatings
 - 2. Section 91 – Paint
- E. Green Seal:
 - 1. GS-03 - Anti-Corrosive Paints.
 - 2. GS-11 - Paints and Coatings.
- F. Master Painters Institute:
 - 1. MPI - Approved Products List.
 - 2. MPI - Architectural Painting Manual.
- G. NACE National Association of Corrosion Engineers
- H. NSF National Sanitation Foundation
- I. SSPC Steel Structures Painting Council

1.4 SEQUENCING

- A. Do not apply finish coats until paintable sealant is applied.
- B. Back prime wood trim before installation of trim.

1.5 SUBMITTALS

- A. [Section 01 33 00 - Submittal Procedures](#): Requirements for submittals.
- B. Product Data:
 - 1. Submit manufacturer data on finishing products, special coatings and paint.
 - 2. Include MPI - Approved Products Lists with proposed products highlighted.
- C. Samples:
 - 1. Submit two (2) paper chip samples, 4 inches by 4 inches in size, illustrating range of colors and textures available for each surface finishing product as scheduled.
 - 2. Painted Samples:

- a. Submit two (2) painted samples, illustrating selected colors and textures for each selected color and system with specified coats cascaded.
 - D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
 - E. Manufacturer Instructions: Submit special surface preparation procedures, substrate conditions requiring special attention.
 - F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- 1.6 CLOSEOUT SUBMITTALS
- A. [Section 01 78 00 - Closeout Submittals](#): Requirements for submittals.
 - B. Operation and Maintenance Data: Submit information on cleaning, touchup, and repair of painted and coated surfaces.
- 1.7 QUALITY ASSURANCE
- A. MPI Standards:
 - 1. Comply with indicated MPI standards.
 - 2. Products: Listed in MPI - Approved Products List.
 - B. Surface Burning Characteristics:
 - 1. Fire-Retardant Finishes: Maximum 25/450 flame-spread/smoke-developed index when tested according to ASTM E84.
- 1.8 DELIVERY, STORAGE, AND HANDLING
- A. [Section 01 60 00 - Product Requirements](#): Requirements for transporting, handling, storing, and protecting products.
 - B. Container Labeling: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
 - C. Inspection:
 - 1. Accept materials on Site in manufacturer's sealed and labeled containers.
 - 2. Inspect for damage and to verify acceptability.

- D. Store materials in ventilated area and otherwise according to manufacturer instructions.
- E. Protection:
 - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
 - 2. Provide additional protection according to manufacturer instructions.

1.9 AMBIENT CONDITIONS

- A. [Section 01 50 00 - Temporary Facilities and Controls](#): Requirements for ambient condition control facilities for product storage and installation.
- B. Storage Conditions:
 - 1. Minimum Ambient Temperature: 45 degrees F.
 - 2. Maximum Ambient Temperature: 85 degrees F.
- C. Application Conditions:
 - 1. Do not apply materials when surface and ambient temperatures are outside temperature ranges required by paint manufacturer.
 - 2. Do not apply exterior coatings during rain, when relative humidity is outside humidity ranges, or when moisture content of surfaces exceeds those required by paint manufacturer.
 - 3. Minimum Application Temperatures for Latex Paints: 45 degrees F for interiors and 50 degrees F for exteriors, unless otherwise indicated by manufacturer instructions.
 - 4. Minimum Application Temperature for Varnish and Finishes: 65 degrees F for interiors and exteriors, unless otherwise indicated by manufacturer instructions.
 - 5. Lighting Level: 80 fc, measured mid-height at substrate surface.

1.10 WARRANTY

- A. [Section 01 70 00 - Execution](#) and [Section 01 77 00 - Closeout Requirements](#): Requirements for warranties.
- B. Furnish five (5) year manufacturer's warranty for paint and coatings.

PART 2 - PRODUCTS

2.1 PAINTS AND COATINGS

A. Manufacturers:

1. Kelly-Moore Paint Company, Inc.
2. Sherwin-Williams Company
3. Vista Paint
4. Dunn-Edwards Corporation
5. Rust-Oleum
6. Glidden Company
7. Behr Process Corporation
8. Or approved equal
9. Substitutions: As specified in [Section 01 60 00 - Product Requirements](#).

B. Materials:

1. Coatings:
 - a. Ready mixed, except field-catalyzed coatings.
 - b. Capable of drying or curing free of streaks or sags.
2. Patching Materials: Latex filler.
3. Fastener Head Cover Materials: Latex filler.
4. Accessories:
 - a. Grade: Commercial.
 - b. Linseed oil.
 - c. Shellac.
 - d. Turpentine.
 - e. Paint thinners.
 - f. Other materials not specifically indicated but required to achieve specified finishes.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION STANDARDS

- A. The following referenced surface preparation specifications of the Steel Structures Painting Council's "Steel Structure Painting Manual, Volume 2, Systems and Specification" shall form a part of this specification:
 1. Solvent Cleaning (SSPC-SP1): Removal of oil, grease, dirt, soil, salts, and contaminants by cleaning with solvent, vapor, alkali, emulsion, or steam.

2. Hand Tool Cleaning (SSPC-SP2): Removal of loose rust, loose mill scale, and loose paint to degree specified, by hand chipping, scraping, sanding, and wire brushing.
3. Power Tool Cleaning (SSPC-SP3): Removal of loose rust, loose mill scale, and loose paint to degree specified by power tool chipping, descaling, sanding, wire brushing, and grinding.
4. White Metal Blast Cleaning (SSPC-SP5): Removal of all visible rust, mill scale, paint, and foreign matter by blast cleaning by wheel or nozzle (dry or wet) using sand, grit, or shot.
5. Commercial Blast Cleaning (SSPC-SP6): Blast cleaning until at least two-thirds of each element of surface area is free of all visible residues.
6. Brush-Off Blast Cleaning (SSPC-SP7): Blast cleaning of all except tightly adhering residues of mill scale, rust, and coatings, exposing numerous evenly distributed flecks of underlying metal.

3.2 EXAMINATION

- A. Verify that surfaces and substrate conditions are ready to receive Work as recommended by product manufacturer.
- B. Evaluate blast cleaned surface preparation work will be based upon comparison of the blasted surfaces with the definitions and standard visual samples available from SSPC, using SSPC-V1S1 Standards.
- C. Examine surfaces scheduled to be finished prior to commencement of Work, and report conditions capable of affecting proper application to City's Project Manager. The Project Manager shall be sole judge as to whether the quality of blast cleaning conforms to visual comparison standards, and the Project Manager's decision as to allowability shall be final.
- D. Test shop-applied primer for compatibility with subsequent cover materials.
- E. Moisture Content:
 1. Measure moisture content of surfaces using electronic moisture meter.
 2. Do not apply finishes unless moisture content of surfaces are below following maximums:
 - a. Masonry, Concrete, and Concrete Unit Masonry: 12 percent.
 - b. Exterior Wood: 15 percent, measured according to ASTM D4442.

3.3 PREPARATION

- A. [Section 01 70 00 - Execution](#): Requirements for application preparation.
- B. Prepare coatings as follows:
 - 1. To soft paste consistency, capable of being readily and uniformly dispersed to homogeneous coating.
 - 2. For smooth flow and brushing properties.
- C. Surface Appurtenances: Remove or mask electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.
- D. The working parts of all mechanical and electrical equipment shall be protected from damage during surface preparation and coating operations. Openings in motors shall be masked to prevent entry of coating or other materials.
- E. Defects:
 - 1. Correct defects and clean surfaces capable of affecting Work of this Section.
 - 2. Remove or repair existing coatings exhibiting surface defects.
- F. Cleaning and coating shall be done such that dust and other contaminants from the cleaning process will not fall on wet, newly-coated surfaces.
- G. Marks: Seal marks that may bleed through surface finishes with shellac.
- H. Impervious Surfaces:
 - 1. Remove mildew by scrubbing with solution of tetra-sodium or tri-sodium phosphate and bleach.
 - 2. Rinse with clean water and allow surface to dry.
- I. Aluminum Surfaces Scheduled for Paint Finish:
 - 1. Remove surface contamination by steam or high-pressure water.
 - 2. Remove oxidation with acid etch and solvent washing.
 - 3. Apply etching primer immediately following cleaning.
- J. Asphalt, Creosote, or Bituminous Surfaces Scheduled for Paint Finish:
 - 1. Remove foreign particles to permit adhesion of finishing materials.
 - 2. Apply latex-based or compatible sealer or primer.
- K. Copper Surfaces Scheduled for Paint Finish:
 - 1. Remove contamination by steam, high-pressure water, or solvent washing.
 - 2. Apply vinyl-etch primer immediately following cleaning.

- L. Copper Surfaces Scheduled for Natural Oxidized Finish:
 - 1. Remove contamination by applying oxidizing solution of copper acetate and ammonium chloride in acetic acid.
 - 2. Rub on repeatedly for required effect, and, once attained, rinse surfaces with clear water and allow to dry.

- M. Galvanized Surfaces:
 - 1. Remove surface contamination and oils, and wash with solvent.
 - 2. Apply coat of etching primer.

- N. Concrete and Unit Masonry Surfaces Scheduled to Receive Paint Finish:
 - 1. Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter.
 - 2. Remove oil and grease with solution of tri-sodium phosphate, rinse well, and allow to dry.
 - 3. Remove stains caused by weathering of corroding metals with solution of sodium metasilicate after thoroughly wetting with water, and allow to dry.

- O. Uncoated Steel and Iron Surfaces:
 - 1. Remove grease, mill scale, weld splatter, dirt, and rust.
 - 2. If heavy coatings of scale are evident, remove by power tool wire brushing or by sandblasting.
 - 3. Clean by washing with solvent.
 - 4. Apply treatment of phosphoric acid solution, ensuring that weld joints, bolts, and nuts are similarly cleaned.
 - 5. Spot-prime paint after repairs.

- P. Shop-Primed Steel Surfaces:
 - 1. Sand and scrape to remove loose primer and rust.
 - 2. Feather edges to make touch-up patches inconspicuous.
 - 3. Clean surfaces with solvent.

- Q. Exterior Wood Scheduled to Receive Paint Finish:
 - 1. Remove dust, grit, and foreign matter.
 - 2. Seal knots, pitch streaks, and sappy sections.
 - 3. Fill nail holes with tinted exterior paintable calking compound after prime coat has been applied.

- R. Exterior Wood Scheduled to Receive Transparent Finish:
 - 1. Remove dust, grit, and foreign matter.
 - 2. Seal knots, pitch streaks, and sappy sections with sealer.

3. Fill nail holes with tinted exterior calking compound after sealer has been applied.

S. Existing Work:

1. Extend existing paint and coatings installations using materials and methods compatible with existing installations and as specified.

3.4 APPLICATION

- A. Comply with MPI - Architectural Painting Manual.
- B. Do not apply finishes to surfaces that are not dry.
- C. Apply each coat to uniform appearance.
- D. Apply each coat of paint slightly darker than preceding coat, unless specified otherwise.
- E. Prime Coat DFT = 3 mils each
- F. Finish Coats (2 or more) DFT = 3 mils each
- G. Total System DFT = 6 mils, minimum.
- H. Sand wood and metal surfaces lightly between coats to achieve required finish.
- I. Cleaning:
 1. Vacuum surfaces to remove loose particles.
 2. Use tack cloth to remove dust and particles just prior to applying next coat.
- J. Fillers:
 1. If clear finishes are required, tint fillers to match wood.
 2. Work fillers into grain before set, and wipe excess from surface.
- K. Concealed Surfaces:
 1. Prime concealed surfaces of interior and exterior woodwork with primer paint.
 2. Prime concealed surfaces of interior wood surfaces scheduled to receive stain or varnish finish with gloss varnish reduced 25 percent with thinner.

3.5 FIELD QUALITY CONTROL

- A. Inspecting and Testing: Comply with MPI - Architectural Painting Manual.

3.6 CLEANING

- A. [Section 01 77 00 - Closeout Requirements](#): Requirements for cleaning.
- B. Collect waste material that may constitute fire hazards, place in closed metal containers, and remove daily from Site.
- C. Improper disposal for hazardous materials will not be allowed.

3.7 COATING SYSTEM

- A. **Alkyd Enamel:** High quality, gloss or semi-gloss, medium long oil alkyd finish shall have a minimum solids content of 49 percent by volume. Primer shall be as recommended by manufacturer.
- B. **Fusion Bonded Epoxy:** The coating material shall be 100 percent powder epoxy applied in conformance with AWWA C550, except that the surface preparation shall be as specified in the Coating System Schedule of this Section.
 - 1. **Liquid Epoxy:** For field repairs, the use of a liquid epoxy will be permitted, applied in not less than 3 coats to provide a total DFT of 12 mils. The liquid epoxy shall be 100 percent solids epoxy recommended by the powder epoxy manufacturer.
 - 2. Field Repair coatings (DFT = 12 mils), Scotchkote 306 or 312, PCI Augsburg DURA-POX 646 or equal.
- C. **Polyethylene Encasement:** Application of polyethylene encasement shall be in conformance with AWWA C 105 using Method A.
- D. **Cement Mortar Coating:** Unless otherwise shown on the Drawings, mortar coating and reinforcement shall be in conformance with AWWA C205.
- E. **Factory Applied Coating:** The coating material shall be a liquid epoxy applied in conformance with AWWA C550.
- F. **Coal Tar Paint:** High Solids content coal tar paint for use on buried pipeline and fittings.
 - 1. Prime Coat and finish coats (2 or more, total DFT = 24 mils), Protecto Wrap CA-1200, Polyguard No. CA-14, Kop-Coat Bituminastic Super Service Black, or equal.

3.8 SCHEDULE

- A. See below Coating System Schedule A for Ferrous Metal and not galvanized.

Item	Surface Preparation	Coating System

<p>All surfaces, indoors and outdoors, exposed or covered, except those surfaces included below</p>	<p>Commercial Blast Cleaning SSPC-SP6</p>	<p>Alkyd Enamel</p>
<p>Exposed Fire Hydrant, valve lids, marker posts, backflow preventor lettering, exposed pipe, fittings and vent pipe</p>	<p>Solvent Cleaning SSPC-SP1</p>	<p>Alkyd Enamel</p>
<p>Buried pipe with a nominal diameter of less than 6 inches and greater than 2 inches, excluding ductile iron pipe</p>	<p>Solvent Cleaning SSPC-SP1</p>	<p>Coal Tar Paint</p>
<p>Fittings and flanged joints, where the piping is plastic. Buried fittings on ductile iron pipe used for FH laterals, fire service laterals, and Backflow Prevention Assemblies. Joints, and fittings on ductile iron pipe with coal tar coating.</p>	<p>Commercial Blast Cleaning SSPC-SP6</p>	<p>Coal Tar Paint</p>
<p>Buried pipe couplings; fittings; and flanged joints, including epoxy coated surfaces, except valves; where the piping is polyethylene encased ductile iron</p>	<p>As specified in Specifications for appropriate fittings</p>	<p>Polyethylene Encasement</p>
<p>Buried pipe couplings, fittings, and flanged joints, where piping is cement mortar coated and lined steel pipe, excluding epoxy coated surfaces.</p>	<p>Solvent Cleaning SSPC-SP1</p>	<p>Cement Mortar Coating</p>
<p>Buried cast couplings, buried sleeve-type tapping sleeves, welded tapping outlets. Ferrous surfaces of gate valves.</p>	<p>White Metal Blast Cleaning SSPC-SP5</p>	<p>Fusion Bonded Epoxy</p>

External ferrous surfaces of check valves and ferrous internal surfaces of fire hydrants.	White Metal Blast Cleaning SSPC-SP5	Fusion Bonded Epoxy
Internal/External Ferrous Surfaces of butterfly valves	White Metal Blast Cleaning SSPC-SP5	Factory Applied Epoxy

B. See below Coating System Schedule B for Ferrous Metal and Galvanized.

Item	Surface Preparation	Coating System
All exposed surfaces, indoors or outdoors, including exposed galvanized pipe, except those surfaces included below.	Alkaline Cleaning per SSPC-SP1	Alkyd Enamel
Buried pipe with a nominal diameter of 2 inches and less, including valves, fittings	Alkaline Cleaning per SSPC-SP1	Coal Tar Paint

END OF SECTION 09 90 00

SECTION 10 14 13
PIPING AND VALVE IDENTIFICATION SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Identification systems for concrete-encased, buried, and exposed piping and valves.

1.2 REFERENCED SECTIONS

- A. The following Sections are referenced in this Section
1. Section 01 33 00 – Submittals
 2. Section 09 96 00 – High Performance Coatings
 3. Section 40 05 10 – Piping Systems

1.3 SUBMITTALS

- A. Comply with Section 01 33 00.
- B. Include the following items:
1. Manufacturer's catalog information demonstrating compliance with the materials requirements of this section.
 2. Samples of the materials to be used for piping and valve identification.
 3. A schedule of piping services and description of identification systems.

PART 2 - PRODUCTS

2.1 PIPE CODING MARKERS

- A. Manufacturers
1. One of the following or equal:
 - a. Brady Company.
 - b. Seton Name Plate Corporation.
 - c. Industrial Safety Supply Corporation.
- B. Comply with ANSI A13.1.
- C. Type
1. Mechanically attached type that is easily removable.
 2. Do not use adhesive applied type.
 3. Pressure sensitive legends applied to plastic backing which is strapped or otherwise mechanically attached to the pipe.
- D. Legend and Backing
1. Resistant to petroleum based oils and grease.
 2. Meet criteria for humidity, solar radiation, rain, salt, fog and leakage fungus, as specified by MIL-STD-810C.
- E. Withstand a continuous operating temperature range of -40°F to 180°F.

- F. Manufactured and applied in one continuous length of plastic. Do not provide individual letter type.
- G. Provide in the following letter heights: For markers bearing the legends on the background colors specified in Section 40 05 10 (PIPESPEC).

Outside pipe diameter, ^(a) inches	Letter height, inches
Less than 1-1/2	1/2
1-1/2 through 3	1 1/8
Greater than 3	2-1/4
^(a) Outside pipe diameter shall include insulation and jacketing.	

- H. Include uni- and bi-directional arrows in the same sizes as the legend. Provide legends and arrows in white on blue or red backgrounds, and black on other specified backgrounds.

2.2 PLASTIC TRACER TAPE

- A. Manufacturers
 - 1. One of the following or equal:
 - a. Brady Company.
 - b. Seton Name Plate Corporation.
 - c. Industrial Safety Supply Corporation.
- B. 6-inch- wide, colored the same as the background colors as specified in Section 40 05 10.
- C. Material: inert plastic material suitable for direct burial.
- D. Capable of stretching to twice its original length.
- E. Print two messages on the tape, both messages at maximum intervals of 2 feet.
 - 1. First message: **“CAUTION CAUTION CAUTION PIPE BURIED BELOW”** with bold letters approximately 2-inch- high.
 - 2. Second message:
 - a. The blank in the first message shall contain the words **“NON-POTABLE WATER”** when used for W2 and IRR piping.
 - b. The blank in the first message shall contain the words **“STORM DRAIN”** when used for SD piping.
 - c. The blank in the first message shall contain the word **“SEWER”** for all other piping systems.

2.3 MAGNETIC TRACER TAPE

- A. Manufacturers
 - 1. One of the following or equal:
 - a. Brady Co.
 - b. Seton Name Plate Corporation
 - c. Industrial Safety Supply Corporation.
- B. Material
 - 1. Acid and alkali-resistant polyethylene.
 - 2. 3-inch-wide.

3. 0.005-inch thick.
 4. 1,500 psi strength and 140% elongation value.
- C. Color the same as the background colors as specified in Section 40 05 10 and inscribe with the words “**CAUTION—PIPE BURIED BELOW**”.

2.4 VALVE IDENTIFICATION

- A. Fabricate of stainless steel and inscribed with the specified valve number stamped in 1/4-inch high letters.
- B. The label shall be of 1/16-inch thick stainless steel with a minimum size of 2 inches.
- C. See Drawings for valve designation system.

2.5 AIR WASH BLOWER AND PUMP IDENTIFICATION

- A. XXX

PART 3 - EXECUTION

3.1 PIPING IDENTIFICATION

- A. Pipe Coding
 1. After application of the specified coating and insulation systems to new piping, as specified in Section 09 96 00, identify exposed piping, interior and exterior, and piping in ceiling spaces, pipe trenches, pipe chases and valve boxes identified with plastic markers.
 2. Locate legend markers and directional arrows at each side of walls, floors and ceilings, at one side of each piece of equipment, at piping intersections, and at approximately 50' centers.
- B. Plastic Tracer Tape
 1. Provide a single line of plastic tracer tape as specified in this section, 2.5 feet above the centerline of each buried pipe.
 2. Spread tape flat with message side up before backfilling.
- C. Polyethylene Magnetic Tracer Tape
 1. Install 12-18-inch below ground and parallel to all buried pipes.

3.2 VALVE IDENTIFICATION

- A. Label all valves designated with a valve number where valve numbers are indicated on the Drawings.
- B. Each label shall be permanently attached to the valve using stainless steel screws, stainless steel wire and connectors, or another method subject to approval.
- C. Install tags on valve flanges in a position visible from floor level.
- D. For flangeless valves 8-inch in diameter and larger, attach tags to the valve body by self-tapping corrosion resistant metal screws.
- E. For flangeless valves 6-inch in diameter and smaller, attach tags to the valve stem by stainless steel wire. Use 0.063-inch wire minimum.

END OF SECTION

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SECTION 10 73 16

METAL CANOPIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes requirements to design, fabricate, deliver to project site and erect pre-engineered canopies, including their anchorage, shown on the Drawings at the following areas and as specified herein.
 - 1. Chemical Storage Area.

1.02 RELATED SECTIONS

- A. Section 01 61 20 – Seismic Design Criteria
- B. Section 01 61 40 – Wind Design Criteria
- C. Section 03 30 00 – Cast-in-Place Concrete
- D. Section 03 60 00 – Grouts
- E. Section 05 50 00 – Metal Fabrications
- F. Section 05 52 00 – Metal Railings
- G. Section 09 90 00 – Painting and Coating

1.03 REFERENCES

- A. American Society of Civil Engineers (ASCE)
 - 1. ASCE 7-16 – Minimum Design Loads for Buildings and Other Structures.
- B. American Society for Testing and Materials (ASTM)
 - 1. ASTM A36 - Standard Specification for Carbon Structural Steel.
 - 2. ASTM A446 – Standard Specification for Steel Sheet Zinc-Coated (Galvanized) by the Hot-Dipped Process, Structural (Physical) Quantity.
 - 3. ASTM A500 – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - 4. ASTM A529 – Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality.
 - 5. ASTM A572 – Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
 - 6. ASTM A992 – Standard Specification for Structural Steel Shapes.
 - 7. ASTM F1554 – Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
 - 8. ASTM F3125 – Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength.
 - 9. ASTM A1011 – Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Cron, Structural, High Strength Low-alloy, High-Strength Low-alloy with Improved Formability, and Ultra-High Strength.

- C. American Institute of Steel Construction (AISC):
 - 1. Steel Construction Manual – 15th Edition.
- D. American Iron and Steel Institute (AISI):
 - 1. North American Specification for the Design of Cold-Formed Steel Structural Members – 2007 Edition.
- E. American Welding Society (AWS):
 - 1. AWS D1.1 – Structural Welding Code Steel.
- F. California Building Standards Commission
 - 1. California Building Code
- G. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 SYSTEM DESCRIPTION

- A. Columns and beams of rigid frame construction serve as primary structural supports. The approved primary structural supports and other systems specified in this Section. shall provide the clear inside height and width shown on the Drawings.
- B. Bracing in roof and between columns shall be furnished and installed where required and approved to provide rigidity against wind and seismic loads.
- C. The overall dimensions of the structure, number and length of bays and roof slope are as shown on the Drawings.
- D. Provide additional framing as required for preformed metal panels, guardrails, ladder, piping supports, lighting fixtures, other appurtenances, and electrical and instrumentation components.

1.05 SUBMITTALS

- A. Submit design calculations for the entire structure, including the anchorage, with the installation drawings to the Engineer for review. Calculations shall be signed and sealed by a Professional Structural Engineer registered in the State of California.
- B. Submit to the Engineer for review complete plans showing superstructure column lines set to coordinate with concrete pedestal dimensions shown. Indicate anchor bolt locations and reactions in KIPS for all load cases, at all columns. Complete design in accordance with Sections 01 61 20 – Seismic Design Criteria and 01 61 40 – Wind Design Criteria.
- C. Submit product information, specifications, and installation instructions for all components and accessories proposed. Submit standard and custom color charts for color confirmation by the Engineer.
- D. Submit shop drawings and complete erection drawings for review, including but not limited to:
 - 1. Anchor bolt and base plate settings.
 - 2. Anchorage supplemental reinforcement or anchor reinforcement, if required.
 - 3. Rigid frames.
 - 4. Roof framing and bracing.
 - 5. Vertical bracing.
 - 6. Fascia.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, and handle prefabricated components, and other manufactured items in accordance with manufacturers' written recommendations to prevent damage or deformation. Stack materials on platforms or pallets, covered with tarpaulins or other suitable weathertight ventilated covering to prevent damage from weather elements.

1.07 QUALITY CONTROL

- A. All items under this Section of the same size/type shall be identical and be furnished by a single supplier. The single supplier shall have sole responsibility for furnishing all of the items required for a complete and operable system; however, components may be manufactured by different vendors. The single supplier shall be one of the following:
 - 1. Varco Pruden Buildings
 - 2. CECO Building Systems
 - 3. or approved equal.

PART 2 - PRODUCTS

2.01 DESIGN CRITERIA

- A. Design primary and secondary members and roof panels for all applicable loads and combinations of these loads as set forth in the California Building Code and as shown on the Drawings.
- B. Column reactions shall be vertical and horizontal only. No bending moments are allowed at the column bases.
- C. The design, fabrication, and erection of the pre-engineered canopy shall conform to the applicable sections of the latest edition or revision of the codes and standards listed in Contract Documents.
- D. Design the pre-engineered canopy to maintain structural integrity and functionality when subjected to the following loads, in addition to the dead load of the structure itself and the wind and seismic loads specified in Sections 01 61 20 Seismic Design Criteria and 01 61 40 Wind Design Criteria.
 - 1. Live Load: The vertical live load of the canopy shall not be less than 20 pounds per square foot applied on the horizontal projection of the roof. Reduction of loads due to tributary loaded areas are not permitted.
 - 2. Collateral Load: Include collateral loads from lighting, conduit, soffit, and process piping in the design of the canopy.
- E. Use cast-in-place anchors for concrete anchorage. Design anchorage in accordance with requirements specified in Section 01 61 20 – Seismic Design Criteria.
- F. Maximum drift: 0.01 times the canopy height.

2.02 MATERIALS

- A. Structural
 - 1. Provide hot-rolled structural steel shapes in accordance with ASTM A529, A572, A992, or A36.
 - 2. Provide members fabricated from plate or bar stock in accordance with ASTM A529 or A572; 50,000 psi minimum yield strength.
 - 3. Provide members fabricated by cold forming in accordance with ASTM A1011SS or A1011HSLAS, Grade 55.

B. Structural Framing Components

1. The structural framing shall consist of rigid steel (W-shape) frames, purlins, roof bracing, side vertical bracings, and framing for roof penetrations. Cold formed secondary framing members shall not be fabricated from or contain material less than 16 gauge. Provide supports for eaves, fascia, pipe supports, lighting fixture supports, and appurtenances as required.
2. Provide bolts in accordance with ASTM F1554 for concrete anchorage and ASTM F3125, Grade A325 for frame connections as necessary for design loads and connection details.
3. Shop fabricate structural framing components to the indicated size and section, complete with base plates, bearing plates, and other plates as required for erection. Weld plates in place and shop drill or punch to template dimensions all required holes for anchors or connections.
 - a. Shop connections – power riveted, bolted, or welded
 - b. Field connections – bolted

C. Roof System

1. Provide flashings, closures for exterior and interior panels, fillers, metal expansion joints, cap flashings, and conduit roof jack flashing, gutters, gutter tailpieces, rain water leaders, and other required sheet metal accessories. Rain water leaders shall be a minimum of 3-inch diameter schedule 40 galvanized steel pipe, attached to columns, and transitioning to cast iron soil pipe at grade.
2. Sheet Panel Fasteners
 - a. Sheet panel fasteners shall be manufacturer's standard system of concealed clips, self-tapping screws, bolts and nuts and washers, blind rivets, self-locking bolts, end-welded studs, and other suitable fasteners selected to withstand the design loads.
 - b. Provide metal-backed neoprene washers under heads of fasteners bearing on the top side of panels. Metal shall match fastener material.
 - c. Use stainless steel or aluminum fasteners for all applications.
 - d. Where exposed, provide fasteners with heads matching color of material being fastened by means of plastic caps or factory applied coating.

D. Fascia

1. Fascia panels shall be a continuous steel plate as shown on the Drawings. Fascia shall be painted as listed in the exterior finish schedule on the Drawings. The panel coating system shall be suitable for a minimum 20-year exterior exposure without chalking.

E. Structural Steel Surface Coating

1. Primary structural steel members where all surfaces can be field coated after erection shall be shop coated with a primer compatible with the industrial coating system for exterior ferrous non-submerged and exterior galvanized coatings specified in Section 09 90 00 – Painting and Coating. After all erection is completed, apply final coating with the selected industrial coating systems per Section 09 90 00 – Painting and Coating.
2. Secondary steel members where one or more surfaces are covered by adjacent steel surfaces shall be galvanized. Exposed galvanized steel members shall be coated per the industrial coating system for exterior galvanized coatings in accordance with Section 09 90 00 – Painting and Coating.

PART 3 - EXECUTION

3.01 MATERIALS RECEIVED

- A. Receive, unload, and inspect all metal canopy components for damage and verify supplied materials are in compliance with the approved submittals. Store off the ground to prevent soiling, warping, or other damage. Defective, damaged, or noncompliant materials shall be replaced or repaired at no additional cost to the District.

3.02 INSPECTION

- A. Examine the foundations, column supports, and the conditions under which Work is to be performed and check anchor bolt setting for line and grade. Notify the Engineer in writing of unsatisfactory conditions.
- B. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.03 ERECTION

- A. Anchor bolts shall be installed in concrete pilasters. Base plates shall be installed and leveled. Anchor bolts shall be double-nutted.
- B. Erect structural framing true to line, level, plumb, rigid, and secure. Level base plates to a true even plane with full bearing to supporting structures and set with double-nutted anchor bolts. Use a non-shrink grout (1-1/2 inch min. thickness) to obtain uniform bearing and to maintain a level base line elevation.
- C. Erect structure in accordance with manufacturer's specifications and written recommendations.

3.04 FIELD PAINTING

- A. Where exothermic welding (e.g., grounding connections) or at attachments to structures and where allowed by the Engineer, touch-up abrasions to factory pre-finished components with air drying paint recommended by the paint manufacturer of the Section 09 90 00 – Painting and Coating.
- B. Apply final industrial coatings in accordance with the requirements of Section 09 90 00 – Painting and Coating.

3.05 PROTECTION AND COMPONENT REPLACEMENT

- A. Protect Work of this Section from damage by other trades. Correct any painting related damages by cleaning, repairing, or replacing and refinishing, as directed by the Engineer.

END OF SECTION

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SECTION 13 34 37
FIBERGLASS TROUGHS AND WEIR PLATES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Furnished and installed fiberglass troughs and weir plates in Filter Nos. 1 through 5, and supports, fasteners and accessories, as shown on the Drawings and as specified herein.

1.02 REFERENCED SECTIONS (NONE)

1.03 REFERENCES

- A. American Water Works Association (AWWA):
1. AWWA F101-02 Standard for Contact-Molded, Fiberglass-Reinforced Plastic Wash Water Troughs and Launderers.
 2. AWWA F102-02 Standard for Matched-Die-Molded, Fiberglass-Reinforced Plastic Weir, Scum Baffles, and Mounting Brackets.
- B. American Society for Testing and Materials (ASTM):
1. ASTM G23 Standard Practice for Operating Light-Exposure Apparatus With and Without Water for Exposure of Nonmetallic Materials.
 2. ASTM D256 – Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
 3. ASTM D570 - Standard Test Method for Water Absorption of Plastics.
 4. ASTM D638 - Standard Test Method for Tensile Properties of Plastics.
 5. ASTM D790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 6. ASTM D2583 - Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol-Impressor.
- C. American National Standards Institute (ANSI) and National Sanitation Foundation International (NSF):
1. ANSI/NSF 61 Drinking Water System Components - Health Effects
- D. California Building Code:
1. Chapter 26 Plastic

1.04 SUBMITTALS

- A. Shop Drawings:
1. Submit complete initial submittals in the Product Review category for favorable review prior to fabrication for:
 - a. Troughs, weir plates, fasteners and accessories, including calculations and drawings of trough lateral stabilization systems.
 - b. Grating.
 - c. Include samples of proposed trough, weir plate material and fasteners to the Owner for favorable review prior to fabrication. Sufficient information shall be included to clearly indicate that proposed material is in compliance

with the Specifications and to show in detail the fabrication method, materials, workmanship, method of attachment to adjacent materials and color of the products proposed to be furnished. Include layout and dimension drawings. Submit block-out dimensions, details, and procedures for installing embedded items.

B. Manuals:

1. Furnish manufacturers' installation instructions and parts lists.

C. Performance Testing:

1. Submit certified test results for troughs indicating compliance with physical properties described in paragraph 2.01.D and for weir plates indicating compliance with physical properties described in paragraph 2.01.F before installation of the grating, troughs and weir plates.

1.05 QUALITY ASSURANCE

- A. Qualifications: All items furnished under this Section shall be supplied by manufacturers who have been regularly engaged in the design and manufacture of similar items for at least five years. Demonstrate to the satisfaction of the Engineer that the quality is equal to the items made by the manufacturers named herein.
- B. Regulatory Requirements: Comply with the International Building Code and the California Building Code, especially Chapter 26, Plastic.

1.06 DELIVERY AND STORAGE

- A. Inspect all items delivered to the site for damage. Replace items that have splintered or suffered surface damage.
- B. Store in a clean area without adding either concentrated or distributed loads above the items. Cover fiberglass material stored outside for more than two months with canvas or other opaque material. Provide for air circulation under the covering.

PART 2 - PRODUCTS

2.01 FIBERGLASS TROUGHES, WEIR PLATES, AND ACCESSORIES

- A. Materials shall comply with requirements in AWWA F101-02 and F102-02, except as modified herein:
 1. Resin: Commercial Type I polyester, suitable for use in potable water.
 - a. Additives:
 - 1) Include catalysts, accelerators or promoters to provide a complete cure of the laminate.
 - 2) Include additives as required to provide ultraviolet (UV) and weather resistance as described in ASTM G23.
 2. Reinforcement:
 - a. Fibrous glass: Type C or Type E fiberglass with silane finish and a binder compatible with the lay-up resin. Glass content shall be 25 to 32% by weight.
 - b. Metallic: Shall be free of rust, oil and foreign matter. Encapsulate metallic reinforcement in a minimum of 1/8th-inch thick laminate.
 3. Color: Provide blue-green color troughs and weir plates by mixing pigment with the resin.

- B. Loading:
1. Troughs will be subject to suddenly applied full buoyancy load upward (when troughs are empty) and full wet load (trough full of water when a filter is dewatered).
 2. Troughs shall be fabricated to the dimensions shown on the Drawings within a tolerance of $\pm 1/8$ -inch. Troughs damaged during construction, transportation or erection will be rejected. Install troughs as shown on the Drawings. Top edges shall be placed level and shall not vary in elevation by more than $1/32$ -inch.
 3. Trough construction shall be such that vertical deflection under maximum loading and vibration does not exceed $3/16$ -inch variation from level over the entire span.
 4. Reinforcing methods shall be such that loading or vibrations over long periods of time will not cause permanent creep in excess of the above tolerances.
 5. Troughs will be subject to ambient outdoor temperature range, and diurnal temperature variations at project site.
 6. Troughs shall be suitable to withstand forces (including thermal stresses) for buoyant and dewatered conditions in hot and cold weather.
 7. The troughs' lengths are greater than spans listed in AWWA F101, Table 2. Trough manufacturer shall furnish lateral stabilization system for troughs.
- C. Manufacturing Process:
1. Troughs:
 - a. The inner surface of the troughs shall be smooth and resin rich. The outer surfaces shall be reasonably smooth and no glass fibers shall be exposed. The size and number of air bubbles shall be held to a minimum. Laminations shall be dense and without voids, dry spots, cracks or crazes.
 - b. The inner surface of the troughs shall be reinforced with glass surfacing mat. This shall be followed with chopped strand glass laminate (maximum 2 oz/ft^2) in a minimum of two layers. Void content of the complete laminate shall not exceed $2-1/2\%$ of laminate volume.
 - c. The top edges of the troughs section shall be level and parallel with a tolerance of $\pm 1/8$ -inch (measured when the trough is not loaded) per 10-foot length.
 - d. The laminate thickness tolerance shall be plus $1/8$ -inch minus 0-inch.
 - e. Thickness at locations of supports such as saddles shall be at least $1-1/2$ times the nominal thickness of the troughs and shall conform to the fiber stress limitations set forth in paragraph 2.01E of this Specification.
 - f. End flanges and blind ends shall be a minimum of $1-1/2$ times the nominal thickness of the trough and shall conform to the fiber stress limitations set forth in paragraph 2.01D of this Specification.
 - g. One-inch-diameter stainless steel spreaders shall be bolted between the troughs walls on approximately 2-foot centers to enhance the structural rigidity of the troughs systems.
 - h. A $1-1/2" \times 1-1/2" \times 1/4"$ steel angle shall be molded within the trough's exterior weir edges for the full weir length.
- D. Trough Laminate Physical Properties:
1. All fiberglass troughs shall have a minimum wall thickness of $1/4$ -inch. Minimum physical properties shall be as follows:

Property	Requirement	Test Method
Tensile Strength	12,000 psi	ASTM D638
Flexural Strength	19,000 psi	ASTM D790
Flexural Modulus	900,000 psi	ASTM D790
Barcol Hardness	35	ASTM D2583
Notched Izod Impact	13 ft-lb/in.	ASTM D256
Water Absorption (maximum 24-hour)	0.2%	ASTM D570
Specific Gravity	1.45 or greater	ASTM D792
Reinforcing Glass Content	25% to 32%	MIL-P-802c, (ash method) 15 July 1957

2. Maintain a continuous quality control program and furnish the Owner with certified test reports consisting of the physical tests listed.
3. Hardness tests shall be made on the resin-rich surface of the product.
4. Flexural tests shall be made with the resin-rich surface in compression.
5. Test samples shall be full thickness of the item produced and shall not be machined on the surface.
6. Mechanical properties shall equal or exceed those listed when tested at 73°F ±3°F.

E. Weir Plates

1. Weirs shall be flat with smooth, resin-rich surfaces, free of voids, dry spots, cracks, exposed glass, or crazes and shall provide for corrosion resistance and weathering. All surfaces shall be sealed with a flood coat of pigmented resin to seal out moisture. Cut holes or edges shall be sanded smooth and resealed with resin.
2. Color: Aqua. Color molded-in with ultraviolet inhibitor.
3. Notch Configuration and Dimensions:
 - a. Weirs cut from flat sheet are not acceptable.
 - b. 90-degree V-notch dimensions shall be as shown on the Drawings. Length of V-notch sections shall be as shown on the Drawings.
4. Mounting Holes: Minimum of 2 inches vertical or horizontal adjustment.
 - a. Straight Runs: 2-1/2-inch diameter at 12 inches on center.
5. Mounting:
 - a. To FRP troughs: 1/2-inch diameter by 1-1/2-inch stainless steel bolt, nut, and 2 washers including 5-inch diameter fiberglass reinforced plastic washer.
6. Splice Plates: Required to secure ends and to allow for horizontal expansion.
 - a. Nominal Thickness: Same as weir.
 - b. Color: Same as weir.

F. Weir Plate Laminate Physical Properties:

1. All fiberglass weir plates shall have a minimum wall thickness of 1/4-inch. Minimum physical properties shall be as follows:

Property	Requirement	Test Method
Tensile Strength	10,000 psi	ASTM D638
Flexural Strength	20,000 psi	ASTM D790
Flexural Modulus	800,000 psi	ASTM D790
Barcol Hardness	35	ASTM D2583
Notched Izod Impact	10 ft-lb/in.	ASTM D256
Water Absorption (maximum 24-hour)	0.2%	ASTM D570
Specific Gravity	1.45 or greater	ASTM D792
Reinforcing Glass Content	25% to 32%	MIL-P-802c, (ash method) 15 July 1957

2. Maintain a continuous quality control program and furnish the Engineer with certified test reports consisting of the physical tests listed.
 3. Hardness tests shall be made on the resin-rich surface of the product.
 4. Flexural tests shall be made with the resin-rich surface in compression.
 5. Test samples shall be full thickness of the item produced and shall not be machined on the surface.
 6. Mechanical properties shall equal or exceed those listed when tested at 73°F ±3°F.
- G. Washers shall be of same material as weirs. Secure ends of weir plates with butt plates arranged to allow horizontal expansion.
- H. Manufacturers: Warminster Fiberglass; F.B. Leopold; or equal.

2.02 FASTENERS

- A. Provide Type 304 stainless steel hold down clips, bolts, nuts, washers and fastener assemblies.

PART 3 - EXECUTION

3.01 FABRICATION

- A. Fabricate all assemblies in the shop to the greatest extent possible.
- B. Repair all cut surfaces with catalyzed resin sealant recommended by the manufacturer.

3.02 INSTALLATION

- A. Surfaces behind fiberglass shall be smooth. Troughs and weir plates shall be installed in strict conformance with the manufacturer's installation instructions, and located as shown on the Drawings.
- B. Embed discharge ends of troughs in grout. Block-out procedures are subject to favorable review by the Engineer. Level trough invert within ± 1/4-inch. Care shall be taken in tightening the bolts so that the fiberglass is not damaged. Grout troughs after leveling.
- C. Adjust weir plates as specified or as directed by the Engineer.
- D. Adjust lengths of plates as necessary due to field conditions as approved by Engineer. Do not perform excessive cutting.
- E. Seal field-cut edges and drilled holes with manufacturer's catalyzed resin sealant.

END OF SECTION

SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Division 26, Electrical covers the work necessary for the complete electrical systems for the City of Pittsburgh Water Treatment Plant (WTP) Filtration Improvements and Hypochlorite Conversion Project. Furnish all materials, labor, and equipment as specified herein, in other Division 26 Specification Sections as listed below, and the Drawings for a complete, operational, tested, and commissioned electrical system.
- B. The requirements of Division 26, Electrical in their entirety apply to all electrical work and equipment furnished on this project whether furnished or specified under this or other Divisions of these Specifications.
- C. The work shall include furnishing, installing, and testing the equipment and materials detailed in the following Sections. Where differences exist between the specific equipment Specification Sections of Division 26 and this Section, the specific equipment Specifications shall govern.

<u>Section No</u>	<u>Title</u>
1.	26 05 19 - Low Voltage Conductors and Cables
2.	26 05 26 - Grounding and Bonding for Electrical Systems
3.	26 05 33 – Raceway and Boxes
4.	26 05 43 - Underground Ducts and Raceways for Electrical Systems
5.	26 05 73 - Electrical System Analyses
6.	26 05 80 - Low Voltage Motors
7.	26 08 00 - Commissioning of Electrical Systems
8.	26 22 13 - Low Voltage Dry Type Distribution Transformers
9.	26 24 16 - Panelboards
10.	26 24 19 – Motor Control Centers
11.	26 27 26 - Wiring Devices – Power and Distribution
12.	26 50 00 – Lighting

- D. The work shall include the following:
 - 1. Furnish and install complete operational systems functionally in accordance with the intent of these Contract Documents including but not limited to:
 - a. Short Circuit Study, System Protective Device Coordination Analysis, Arc Flash Calculations, and other electrical system modeling work.
 - b. Testing of the electrical equipment and making final settings for the electrical protective devices.
 - c. Startup and commissioning of the electrical system and components.

2. Coordinate the details of equipment layouts and construction for all Specification Divisions which affect the work covered under Division 26, Electrical.
3. Furnish and install all incidental items not specifically shown or specified, but which are required by good practice and standards of the industry to provide complete functional systems.
4. Coordination and work associated with equipment provided under technical Divisions 2 through 23 of these Specifications including but not limited to: mechanical systems packaged with electrical equipment, motor operated valves with integral controls, pump motors with motor protection controls, field instrumentation.
5. Coordination and work associated with Division 40 – Process and Instrumentation, for installation of plant control system including but not limited to: control networks and media converters, computers, control panels, conduit, wire, and terminations as required.
6. Coordination and work associated with **Division 23** - Heating, Ventilation, and Air Conditioning; provide power and control wiring for all heating, ventilating, and air conditioning equipment including disconnect switches, raceways, and wiring for 120 Volt (nominal) thermostats. Refer to **HVAC** Drawings for the locations of 120 Volt thermostats and provide at a minimum a 3/4-in C, 2 No. 12 and 1 No. 12 GRD between each device and its respective control thermostat unless shown otherwise on the Drawings.
7. Conduit, wire and field connections for all motors, motor controllers, control devices, control panels and electrical equipment furnished under other technical sections of these Specifications.
8. Conduit, wiring and terminations for all field-mounted instruments furnished and mounted under other Divisions, including process instrumentation primary elements, transmitters, local indicators, and control panels; lightning and surge protection equipment wiring at process instrumentation transmitters and analyzers; instrumentation disconnect switches; installation of vendor furnished cables specified under other Divisions.
9. A complete raceway system for the data highway cables, fiber optic, and specialty cable systems. Install the data highway cables, fiber optic, and other specialty cable systems furnished under Division 40 in accordance with the system manufacturers' installation instructions. Review the raceway layout, prior to installation, with the control or computer system supplier(s) and the cable manufacturer(s) to ensure raceway compatibility with the systems and materials being furnished. Where redundant cables are furnished, install cables in separate raceways. Maintain an 8 foot (minimum) separation between raceways.
10. Installation of variable frequency drives, reduced voltage starters, and other packaged motor control equipment, accessories, and appurtenances furnished under other Divisions.
11. Certain pieces of laboratory or process equipment (e.g., still, water-baths, fume hood, etc.) are furnished unassembled. Perform all electrical work necessary to make this equipment operative.
12. Modifications to existing control systems including installation of auxiliary motor starter contacts, relays, switches, as required to provide the control functions or inputs as shown on the Drawings. Verify all existing wiring and connections for correctness. Trace the circuits in the field and develop the wiring diagrams necessary for completion of the work. Document all changes made to the wiring diagrams and return a marked-up set of Record Drawings to the Owner after the work is complete.

13. [Coordinate the sequence of demolition with the sequence of construction to maintain plant operation [in accordance with Section [REDACTED]]. Remove and demolish equipment and materials in such a sequence that the existing and proposed plant will function properly with no disruption of treatment and as specified under Section 26 05 05.]
 14. [Modifications to existing motor control centers, switchboards, panelboards, and motor controllers including installation of circuit breakers or disconnection of circuits as required to provide power supplies to new and existing equipment to maintain the plant in operation and as specified in Section 26 05 05.]
 15. Seismic calculations, anchoring, and restraints for electrical equipment and systems requiring such restraints as required under Section 01 61 20.
- E. Each bidder shall, before preparing their proposal, visit all areas of the existing buildings and structures in which work is to be performed and carefully inspect the present installation. The submission of a proposal by a bidder shall be considered evidence that the bidder has visited the facility, buildings, and structures; noted the locations and conditions under which the work will be performed; and incorporated these locations and conditions into their proposal with respect to the factors governing the work.
- F. Sequencing and Scheduling
1. Coordinate electrical equipment installation with other building components.
 2. Arrange for chases, slots, and openings in the building structures during the progress of construction to allow for the electrical installation.
 3. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
 4. Sequence, coordinate, and integrate the installation of electrical materials and equipment for efficient flow of the work. Coordinate the installation of large equipment requiring positioning prior to closing in the building.
 5. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

1.02 RELATED WORK

- A. Section 01 61 20 - Seismic Design Criteria
- B. All trenching, drilling, backfill, compaction, and surface restoration shall be as indicated on the Drawings and as required under Division 31 of these Specifications.
- C. All concrete and reinforcement shall be as indicated on the Drawings and as required in Division 3 of these Specifications. However, the responsibility of furnishing and installing the underground systems shall be included under this Section.
- D. Process; heating, ventilation, and air conditioning (HVAC); and building support equipment requiring electrical work are specified in the other Technical Sections of these Specifications: Divisions 1 through 40.
- E. Instrumentation and Controls are included in Division 40.

1.03 SUBMITTALS

- A. General

1. Submit manufacturers' descriptive information and shop drawings for all equipment, material, and devices furnished under Division 26 Sections. Prepare and format submittals in accordance with Section 01 33 00 and as specified herein.
2. Mark submittals to clearly identify proposed equipment including accessories, options, and features and to exclude information, products, options, or parts not applicable to the Project.
3. If the equipment installed during construction does not match the equipment that was approved by the Engineer during submittal review, the Contractor shall resubmit all documentation related to the installed equipment as specified. Should the unapproved equipment be found not to be in conformance with the Contract Documents, it shall be removed and replaced with suitable equipment at the Contractor's expense.
4. Review of submittal information by the Engineer shall not relieve the Contractor from responsibility for deviations from Drawings and Specifications, unless he has in writing at time of submission requested and received written approval from the Owner for specific deviations. Review of submittal information shall not relieve the Contractor from responsibility for errors and omissions in shop drawings or literature.
5. Where submittal documents are submitted in electronic format, the engineer reserves the right to request a hard copy of the package for review of complex drawings or shop drawing information. For large electronic packages over 50 pages in length, provide suitable electronic indexing or book marking to match the table of contents, tabulations, drawings, individual product material catalog cut sheets or other documents types provided. Indexing or bookmarking shall be used to facilitate navigation and review of the document. Large electronic packages submitted without such indexing shall be returned to the Contractor unreviewed.
6. Check information and shop drawings for accuracy prior to submittal. Stamp shop drawings with the date checked and a statement signed by the Contractor indicating that the information and shop drawings conform to the requirements of the Contract Documents. This statement shall also list all exceptions incorporated into the Contract Documents. Shop drawings without this signed and dated statement shall be returned unreviewed, marked NOT APPROVED.
7. The Engineer's review of the submittal information shall only be for general conformance with the design concept and the information given in the Contract Documents. The Engineer's review does not relieve the Contractor from responsibility for errors or omissions in their submittal; Contractor's compliance with the Plans and Specifications, applicable laws, codes and regulations; or the Contractor's responsibility of addressing any deviations from the Contract Documents.
8. Review of a specific item in a submittal shall not constitute review of an assembly of which the item is a component.
9. The Contractor is responsible for: confirming and correlating all quantities, dimensions, details, tolerances, and clearances; for all information that pertains to the fabrication processes or to the means, methods, techniques, sequences, and procedures of construction; coordination of the Work with that of all other trades and for performing the Work in a safe and satisfactory manner. All dimensions shall be field verified at the job site and coordinated with the work of all other trades performing work under this Contract.
10. Material shall not be ordered or shipped until the submittal information or shop drawings have been approved. No material shall be ordered, or shop work started

if shop drawings are marked “–MAKE CORRECTIONS NOTED,” "AMEND AND RESUBMIT”, or “REJECTED AND RESUBMIT.”

B. Electrical System Project Plan

1. Submit an initial Project Plan for the elements of the Project to be performed under Division 26. The Project Plan shall be submitted and satisfactorily reviewed before further submittals will be accepted or reviewed. Any and all project submittals received prior to submittal and satisfactory review of the Project Plan shall be returned to the Contractor with a “Not Reviewed” status.
2. Provide an overview of the proposed Project electrical elements in clear text format describing understanding and approach to the overall project work, interfaces to process equipment and systems, interfaces to the Project control system requirements specified under Division 40, schedule, testing, startup, and coordination.
3. Submit a proposed list of anticipated Division 26 shop drawings and submittals.
4. Submit Project schedule prepared and submitted using Microsoft Project scheduling software or similar. Schedule shall be prepared in Gantt chart format clearly showing all major tasks, task dates and durations, milestone dates, linkages between tasks, and identification of critical path elements. At a minimum, the project schedule included in the project work plan for the work specified in Division 26 shall include:
 - a. Demonstration of coordination with the overall project plan provided by the General Contractor under Special Provisions.
 - b. All subsequent Division 26 project submittals. Include in the scheduled time durations the time required for submittal preparation and submittal review. Include provision for a minimum of two complete review cycles.
 - c. Proposed dates for any project specified Coordination Workshops with Owner, Utility, or other entities.
 - d. Purchasing, fabrication, and assembly (following approval of related submittals)
 - e. Shipment of major equipment
 - f. Installation of major equipment.
 - g. Testing: Schedule for all testing including at a minimum the testing sequence as specified under Section 26 08 00. Testing schedule shall include submittal of test procedures a minimum of 30 days prior to commencement of testing. Schedule shall also include submittal of completed test procedure forms for review and approval by Engineer and Owner prior to shipment, startup, or subsequent project work.
 - h. Schedule for system cutover, startup, and/or going on-line for each major system. At a minimum include the cut over schedule for each major electrical distribution, motor control centers, special systems, and other systems critical to the execution of the work performed under this Contract.
 - i. Schedule for all training including submittal and approval of O&M manuals, factory training, and site training.
 - j. Identification and timing for receipt of any Owner furnished information.
 - k. Control system project submittals.
 - l. Proposed dates for project Coordination Workshops.

- m. Hardware and software purchasing, fabrication, and assembly (following approval of related submittals)
- n. Procurement, shipment, and installation of all field instrumentation and control system equipment
- o. Schedule for system testing, cutover, startup, and/or going on-line for each major system.

C. Seismic Requirements

- 1. Submit seismic mounting and anchorage calculations for electrical equipment as follows:
 - a. Where specifically called for in the specific Technical Sections of Division 26.
 - b. Where required under the requirements of Section 01 61 20.
- 2. Submit an itemized list 90 days following Notice To Proceed indicating all systems and equipment for which seismic anchoring will be provided under Contract. The list shall include equipment designation, raceway identifier, cable tray tag, and similar items as shown on the Contract Documents. The list shall also include the Electrical Drawing number where the specific anchoring system is to be located.
- 3. Prepare and submit seismic anchorage and mounting calculations as specified conforming to the requirements and technical criteria per Section 01 61 20.
- 4. Installation of equipment shall not proceed until mounting and anchoring calculations have been submitted and approved.

D. Operation and Maintenance Data

- 1. Submit operations and maintenance data for equipment furnished under this Division, in accordance with Section 01 78 23. The manuals shall be prepared specifically for this Project. Include catalog data sheets, layout drawings, control drawings, equipment lists, functional descriptions, and bills of materials or parts lists with replacement part numbers.
- 2. The manual provided under this Section shall consist of the individual O&M information provided under the other technical sections of Division 26. Coordinate and organize this information into a single, comprehensive, electrical system O&M manual subject to the specified requirements.
- 3. Manuals shall include the following as a minimum:
 - a. A comprehensive index of the major equipment provided.
 - b. A functional description of the entire system with references to the individual system elements, schematic drawings, and instructions.
 - c. A complete "As-Built" set of approved shop drawings.
 - d. A complete list of the equipment supplied, including serial numbers, ranges, and pertinent data.
 - e. A table listing sorted by equipment designation of the "as left" settings for all control, timing, and protective relays defining all timing, alarm, and trip setpoints.
 - f. System schematic drawings "As-Built," illustrating all components' electric connections of the systems supplied under this Section.

- g. Detailed service, maintenance and operation instructions for each item supplied.
 - h. Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.
 - i. Complete parts list with stock numbers, including spare parts.
 - 4. Incorporate final versions of electrical analyses reports and studies as specified under Section 26 05 73.
 - 5. Incorporate final versions of electrical test reports as specified under Section 26 08 00.
- E. Equipment Interconnection and Point-To-Point Wiring Diagrams
 - 1. Review shop drawings of equipment furnished under this Contract and prepare detailed point-to-point (PTP) interconnection wiring diagrams for all equipment requiring an electrical connection; either control, signal, or power, as indicated. All communication system wiring shall be included.
 - a. Submit samples of the PTP interconnection diagrams to the Engineer for approval at the beginning of the construction phase. The sample drawings shall indicate the drawing format, equipment and device labeling and wire tagging methodology to be used for all diagrams. The sample diagrams shall be used as templates for the completed drawing set.
 - b. Submit preliminary diagrams or wiring connection tables prior to commencement of conduit layouts and installation. Preliminary diagrams shall present the wire and conduit systems in sufficient detail to allow review and verification of the circuiting. However, final termination details for circuits shall not be required.
 - c. Submit completed diagrams including circuit termination details as specified prior to pulling in any conductors.
 - d. Submit final versions of interconnection diagrams with all changes made during construction with Record Drawings.
 - 2. Point-to-point connection diagrams shall be produced with **AutoCAD 2020** software. Each PTP connection diagram shall be submitted on 11-in by 17-in sheets with all information needed for installation, checkout, startup, and maintenance included. Provide standard title block including Owner identification, Project Name, Facility, and equipment identifiers. Minimum drawing font size shall be 0.125 inches.
 - 3. A final set of connection diagrams in both “.PDF” and native “.DWG” electronic formats shall be submitted with the final O&M documentation. Provide all necessary XREF, font, shape, and other auxiliary files necessary for accessing and editing these drawings by the Owner, as necessary.
 - 4. A separate drawing shall be provided for each piece of equipment or diagram. One complete diagram shall be included on a drawing with continuation points to other sheets provided as required for creating the complete interconnection system.
 - 5. Interconnection diagrams shall include the following information at a minimum:
 - a. Circuit origin and destination.
 - b. Unique wire numbers as developed by the Contractor incorporating equipment identification, terminal block identification, and terminal block number.

- c. Field wiring terminal strip names and numbers; terminal block point numbers.
- 6. Provide the following general interconnection diagrams at a minimum. Provide additional type of diagrams where required for the specific requirements of the provided equipment:
 - a. Motor and remote device(s) connection to a motor control center or motor starter and process control system panel.
 - b. Motor and remote device(s) connection to a variable frequency drive remote panels and process control system panel.
 - c. Skid mounted vendor equipment, including a vendor-furnished control panel connections to the remote power source, to instrumentation and control devices, and to a process control system panel.
 - d. Field instrument connection to a local control panel and/or process control system panel.
 - e. Gate or valve actuator connection to power and remote control panel and process control system panel.
- 7. An example of the point-to-point connection diagrams is included in the Contract Documents for reference.

1.04 STANDARDS, CODES, PERMITS, AND REGULATIONS

- A. Electrical equipment, materials and installation shall comply with NFPA 70®, the National Electrical Code® (NEC®), 2020 edition, and the 2022 California Electrical Code (CEC). All references to the NEC included in the Contract Documents shall be interpreted to be referenced to this edition with the California Amendments as specified.
- B. Perform work; furnish, install, and test materials and equipment in full accordance with applicable rules, regulations, requirements, and specifications of the following. Where reference is made to one of the standards, the revision in effect at the time of bid opening shall apply.
 - 1. Local Laws and Ordinances
 - 2. State and Federal Laws
 - 3. State Building Codes
 - 4. State Fire Marshal
 - 5. Cal/OSHA – the California Division of Occupational Safety and Health (DOSH)
 - 6. Institute of Electrical and Electronics Engineers (IEEE)
 - a. IEEE C2 - National Electrical Safety Code (NESC)
 - 7. National Electrical Contractors Association (NECA)
 - a. National Electrical Installation Standards (NEIS)
 - 8. National Electrical Manufacturers Association (NEMA)
 - a. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
 - 9. National Fire Protection Association (NFPA)
 - a. NFPA 820 – Standard for Fire Protection in Wastewater Treatment and Collection Facilities

10. InterNational Electrical Testing Association (NETA)
 - a. NETA ATS – Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems
 - b. NETA MTS - Standard for Maintenance Testing Specifications for Electrical Power Equipment and Systems
11. Pacific Gas and Electric Company (PG&E), Electric & Gas Service Requirements (Green Book)

or

Southern California Edison (SCE) Transmission and Distribution Electrical Service Requirements (ESR)

- C. Where conflicts may occur between the above items, the more stringent applicable requirements shall apply. Wherever the requirements of the Specifications or Drawings exceed those of the above items, the requirements of the Specifications or Drawings govern. Code compliance is mandatory. Construe nothing in the Contract Documents as permitting work not in compliance with applicable codes and standards.
- D. Underwriters Laboratories Inc. (UL) listing is required for all equipment and materials where such listing is offered by the Underwriters Laboratories Inc. Safety labeling and listing by other organizations such as Intertek's ETL Listed Mark, FM Approvals certification, or other nationally recognized entity may be substituted for UL labeling and listing if approved by the Engineer. Provide UL service entrance labels for all equipment required by the NEC to have such labels.
- E. Equipment, materials, and installation shall comply with the requirements of the local Authority Having Jurisdiction (AHJ). Obtain all permits and pay all fees required by any governmental agency or utility having jurisdiction over the work. Coordinate and arrange all inspections required by these agencies. On completion of the work, submit satisfactory evidence to the Engineer that the work is acceptable to the regulatory authorities having jurisdiction.

1.05 INTERPRETATION OF CONTRACT DOCUMENTS

- A. The Contract Drawings indicate the extent, general location, and arrangement of equipment. Duct bank and conduit runs are diagrammatic and may not show the exact locations for installation. Verify locations of conduit stub-ups based upon conduit entry space of equipment furnished from the manufacturer's certified shop drawings, by inspection of the actual equipment to be installed, and coordinated with other trades. Stub up conduits as near as possible to equipment terminal enclosures.
- B. Except where dimensions are shown, the locations of equipment, fixtures, outlets and similar devices shown on the Drawings are approximate only. Exact locations shall be determined by the Contractor and approved by the Engineer. Obtain information relevant to the placing of electrical work including final equipment dimensions and installation criteria. In case of any interference with other work, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the work in an approved manner.
- C. Standard details are typical for all locations to which they apply regardless of whether a specific reference callout is shown on the Drawings.
- D. Confirm the incoming phase rotation (e.g., "ABC", "ACB") and adjust the phase sequencing at the main service equipment terminations to the facility to provide ABC rotation for new

facilities. For existing facilities, Contractor shall confirm the existing rotation conditions and adjust the terminations of the incoming utility rotation to match. In no case shall the incoming utility rotation be different from the existing rotation conditions at the site.

- E. Schematics and wiring diagrams included in the Drawings are intended to show the functional requirements for equipment operation, interlocks, and alarming within the depicted circuits. The contractor shall furnish and install all necessary wiring, relays, devices, and timers to provide a fully functional control circuit. At a minimum, circuits shall function as follows:
 - 1. When energized, control circuits shall initialize to a functionally ready-to-operate condition, without requiring any operator intervention to reset or initialize the circuit.
 - 2. Emergency stop pushbuttons, when engaged, shall disable control circuits and prevent the associated equipment from operating under any modes or conditions.
 - 3. Safety interlocks and alarms, when active, shall prevent the associated equipment from operating under any modes or conditions, unless a specific override function is specified.
 - 4. Circuit elements with alarm contacts that are in the alarmed condition in their latent state, such as a low discharge pressure switch, shall include interlocking equipment status contacts and time-delay relays to prevent the alarm circuit from energizing when the equipment is not running.
 - 5. Reset functions for latched alarm conditions shall only reset the alarm circuit if the alarm condition has cleared.
- F. Unless otherwise approved by the Engineer, conduits shown exposed on the Drawings shall be installed surface mounted or suspended as applicable; conduits shown concealed on the Drawings shall be installed in walls, floor slabs, or ceilings as applicable.
- G. Install each 3-phase circuit in a separate conduit unless otherwise shown on the Drawings.
- H. Conduit routing, layouts, or "home runs" shown on the Drawings are not intended to show the number of fittings or other installation details. Furnish all labor and materials necessary to install and place in satisfactory operation all power, lighting and other electrical systems shown.
- I. Verify the exact locations and mounting heights of lighting fixtures, switches and receptacles prior to installation.
- J. Number and size of wires which shall be installed in runs of conduit where not shown on the Drawings shall be determined from the single line diagram, schematics, connection, interconnection, and control diagrams of the actual equipment furnished.
- K. Raceways and conductors for lighting, switches, receptacles and other miscellaneous low-voltage power and signal systems specified are not shown on the Drawings. Raceways and conductors shall be provided as required for a complete and operating system.
 - 1. Home runs, as shown on the Drawings, are to assist the Contractor in identifying raceways to be run exposed and raceways to be run concealed.
 - 2. Raceways shall be installed concealed in all finished spaces or above suspended ceilings unless otherwise noted. Raceways may be installed exposed or concealed in all process spaces.
 - 3. Raceways installed exposed shall be routed near the ceiling or along walls of the areas through which they pass and shall be routed to avoid conflicts with HVAC

ducts, cranes, hoists, monorails, equipment hatches, doors, windows, and other similar equipment.

L. Modifications or Substitution of Equipment

1. Where a specific material or equipment is listed in the Specifications or on the Drawings, it is understood and construed as meaning to indicate a standard of quality. Unless specifically noted otherwise, such listing is not intended in any way to bar the use of any material or equipment that is of equal or better quality.
2. The Electrical Drawings have been prepared based on the equipment first named in the Specifications. The Contractor shall note that the second-named equipment, if given, is considered acceptable and equal equipment, but in some cases additional work or material may be required to accommodate the second-named equipment into the project. The Contractor desiring to use the second-named equipment or any equal equipment, is responsible for all costs including cost of any engineering, material, or installation incurred by using other than the first-named equipment.
3. Likewise, redesign of electrical or mechanical work, which is required due to the Contractor's use of an alternate item, arrangement of equipment and/or layout other than that shown on the Contract Documents, shall be performed at the Contractor's expense. The Contractor shall pay for all such changes including protective devices, bus ratings, conduit, wire, building modifications, and other similar items.
4. The Contractor shall be responsible for preparing any required engineering documents specified under Division 26. Where indicated, submit documents stamped and signed by a Professional Electrical Engineer currently registered in the State of California.
5. Changes from the layout shown to facilitate use of alternate equipment shall not be a basis for additional payment; neither shall changes in electrical controls, wiring or piping caused by the use of second-named or equal equipment be a basis for additional payment.

1.06 PROJECT/SITE REQUIREMENTS

- A. Elevation: Equipment shall be designed to operate at a ground elevation of approximately **XXXX** feet above mean sea level.
- B. Temperature:
1. Equipment located in exterior locations shall be suitable for operation at temperatures from **-XX° to +XX°C** ambient.
 2. Equipment located in internal areas shall be suitable for operation:
 - a. In conditioned spaces **from +XX° to +XX°C** ambient.
 - b. In unconditioned spaces from **-XX° to +XX°C** ambient
 3. Were applicable, equipment shall be rated for extended storage temperatures ranges from **-XX° to XX°C** ambient.
- C. Relative Humidity: Equipment located in air-conditioned spaces shall be suitable for **XX to XX percent** relative, non-condensing humidity. All other equipment shall be suitable for 0 to 100 percent relative, condensing humidity.

- D. Provide equipment and devices suitable for continuous operation at the temperatures and elevations at the site and at the facility installation locations shown on the Drawings.
1. Provide equipment capable of continuous operation at the required rated output shown on the Contract Documents at the specified site conditions.
 2. Provide any additional equipment such as passive thermal cooling, insulation, sunshades, heating, cooling equipment, or other means so that the rated performance requirements can be met. Such equipment shall be provided at no additional cost to the Owner.
 3. Provide suitability derated equipment if required based on the site conditions. Derated equipment shall be provided with revised manufacturer's nameplates stating the equipment rating for continuous duty and the environmental conditions upon which the continuous rating applies. Deration of equipment shall only be allowed if the derated equipment rating conforms to the required equipment ratings as shown on the Contract Documents.
 4. Provide supplementary equipment deration, if required, for both ambient temperature extremes and elevation as required by the manufacturer.

1.07 ENCLOSURE TYPES

- A. Unless otherwise indicated in the Contract Documents, electrical enclosures, conduit systems, and electrical installations shall conform to the following ratings:
1. NEMA 1: indoor, above grade locations subject to clean, dry, and non-process conditions including but not limited to:
 - a. Administration areas
 - b. Office areas
 - c. Dedicated conditioned electrical rooms
 - d. Laboratories
 - e. Control rooms
 2. NEMA 12: indoor, above grade locations subject to non-corrosive, dry or damp process areas, or dusty conditions including but not limited to:
 - a. Dedicated non-conditioned electrical rooms
 - b. HVAC equipment rooms
 - c. Process mechanical equipment rooms
 - d. Maintenance shops
 3. Type 3R: indoor or outdoor locations used to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects and water, and that will be undamaged by the external formation of ice on the enclosure.
 4. NEMA 4: outdoor locations, below grade structures, and indoor locations subject to non-corrosive, wet, or dirty conditions including but not limited to:
 - a. Outdoor facilities
 - b. Basements
 - c. Buried vaults

- d. Below grade process facilities
 - e. Hose down areas
 - f. Non-corrosive process treatment basins, tanks, or vessels.
5. NEMA 4X: locations subject to corrosive or marine conditions including but not limited to:
 - a. Chemical feed or storage areas
 - b. Wastewater treatment areas
 - c. Wastewater or other corrosive process treatment areas (basins, tanks, or vessels)
 6. NEMA 7: locations in hazardous classified indoor locations as shown on the Drawings and as required per the NEC and NFPA 820.
 7. NEMA 7 (gasketed) in hazardous classified outdoor locations as shown on the Drawings and as required per the NEC and NFPA 820.

1.08 HANDLING AND SIZE OF EQUIPMENT

- A. Investigate each route at the facility through which electrical equipment must pass to reach its final installed location. Coordinate shipping splits with the manufacturer to permit safe handling and passage through restricted areas in the facility and within structures.
- B. The equipment shall be kept upright at all times during storage and handling. Should the equipment require tilting for passage through restricted height areas, brace the equipment to ensure that the tilting does not impair the structural or functional integrity of the equipment.

1.09 MAINTENANCE

- A. Spare Parts
 1. Spare parts shall be in accordance with **Section 01750** and as defined in the related technical specification sections. All spare parts shall be new and unused, provided in original packaging.
 2. All spare parts shall be individually packaged and labeled with the part designation and the associated end use equipment tag designation as shown on the Contract Documents.
 3. Provide one pint of touch-up paint, in one-quart containers for each type and color used for all cabinets, panels, consoles, and similar equipment, supplied under the related specification sections.
 4. The spares listed above shall be packed in a manner suitable for long-term storage and shall be adequately protected against corrosion, humidity, and temperature.

1.10 RECORD DRAWINGS

- A. As the work progresses, clearly and legibly record all field changes on a set of project contract drawings, hereinafter called the "record drawings set". The record drawing set shall conform to the requirements of **Section 01710**.
- B. The record drawing set shall be kept at the job site and readily available for review by the Owner or the Engineer.

- C. Record drawings shall be updated daily by the Contractor to provide an accurate record of the current condition of the work.
- D. The record drawing set shall accurately show the installed condition of the completed project. The record drawing set shall accurately document the final locations and conditions of the following items:
 - 1. One-line diagrams.
 - 2. Raceways and pull boxes.
 - 3. Conductor sizes and conduit fills.
 - 4. Lighting and distribution panelboard schedules.
 - 5. Control wiring diagrams.
 - 6. Lighting fixtures, receptacles, and switches.
 - 7. Underground electrical system raceway and duct bank routing shown on the plan drawings. Routing shall include final installation depths below finished grade. Final locations of handholes and manholes shall be documented using the project coordinate system.
 - 8. Plan views of switchboards, distribution transformers, substations, motor control centers and panelboards; include dimensioned outline of final installed location of the equipment.
 - 9. Grounding system including location of ground rods and routing of grounding electrode conductors and ground grid components.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Where two or more units of the same class of material or equipment are required, provide products of a single manufacturer.
- B. Unless otherwise indicated, provide materials and equipment which are the standard products of manufacturers regularly engaged in the production of such materials and equipment. Provide the manufacturers' latest standard design that conforms to these Specifications.

2.02 SEISMIC REQUIREMENTS

- A. General: All products to be furnished under this contract shall be designed, constructed, and installed in conformance with the seismic requirements of Section 01 61 20.
- B. Provide equipment seismically certified for application at the Project site where specifically called for in other Sections of Division 26.

2.03 EQUIPMENT IDENTIFICATION

- A. Identify all equipment, disconnect switches, separately mounted motor starters, control stations, etc. furnished under Division 26 with the name of the equipment it serves unless otherwise noted. Motor control centers, control panels, panelboards, switchboards, switchgear, junction or terminal boxes, transfer switches, etc., shall have nameplate designations as shown on the Drawings.

- B. Nameplates shall be engraved, laminated plastic, not less than 1/16-in thick by 3/4-in by 2-1/2-in with 3/16-in high black letters on a background.
- C. Edges of the nameplates shall be beveled and smooth. Nameplates with chipped or rough edges will not be acceptable.

2.04 MARKINGS AND EQUIPMENT WARNING SIGNS

- A. Electrical Safety and Working Clearance Identification
 - 1. Provide a painted outline about electrical equipment to identify areas that are to be kept clear of storage and debris. The painted outline shall consist of a 3 inch wide, neatly painted line, utilizing safety yellow paint appropriate for the surface being painted.
 - 2. The nearest edge of the line shall be 48 inches in front of electrical equipment rated 600V and lower. Line shall extend to the edge of the equipment or 15 inches from the centerline of the equipment, whichever is greater.
- B. Provide arc flash warning labels on electrical power distribution equipment per Section 26 05 73.
- C. Provide high voltage warning labels and signage on electrical power distribution equipment in conformance with OSHA.
- D. Permanent warning labels shall be mounted at all mechanical equipment which may be started automatically or from remote locations. Labels shall be in accordance with OSHA regulations for personnel safety and shall be suitable for exterior use. The warning labels shall be self-adhesive or fastened with stainless steel screws or bolts as required by the equipment mounting surface. Locate and mount labels as approved by the Engineer. Warning sign shall display the following:

CAUTION
THIS EQUIPMENT STARTS
AUTOMATICALLY
BY REMOTE CONTROL

- E. Permanent warning labels shall be mounted at all electrical equipment enclosures where a voltage sourced from outside the enclosure is present. Labels shall be yellow colored Lamicaid or equal material, engraved with a minimum 1/4" lettering mounted on the front exterior of the panel approximately 5' above finished floor or grade. The warning labels shall be self-adhesive or fastened with stainless steel screws or bolts as required by the equipment mounting surface. Locate and mount labels as approved by the Engineer. Warning sign shall display the following:

CAUTION
FOREIGN VOLTAGES
PRESENT

2.05 FASTENERS

- A. Fasteners and anchors for securing equipment to walls and floors shall be either hot dip galvanized after fabrication or stainless steel unless noted otherwise.

PART 3 - EXECUTION

3.01 GENERAL

- A. Unless specified otherwise, electrical equipment and anchoring systems shall be designed to withstand seismic forces as specified in Section 01 61 20.
- B. Install materials and equipment in a workmanlike manner utilizing craftsmen skilled in the particular trade and conforming to standards of the industry. Provide work which has a neat and finished appearance. Carry out work in accordance with NECA Standard of Installation unless otherwise shown in the Contract Documents.
- C. Coordinate electrical work with the Engineer and work of other trades to avoid conflicts, errors, delays, and unnecessary interference with operation of the plant during construction.
- D. Check the approximate locations of light fixtures, electrical outlets, equipment, and other electrical system components shown on Drawings for conflicts with openings, structural members, and components of other systems and equipment having fixed locations. In the event of conflicts, notify the Engineer in writing. The Engineer's decision shall govern. Make modifications and changes required to correct conflicts.
- E. Follow manufacturers' installation instructions explicitly, unless otherwise indicated on the Contract Documents. Wherever any conflict arises between the manufacturers' instructions, codes and regulations, and these Contract Documents, follow Engineer's direction. Keep copy of manufacturers' installation instructions on the jobsite available for review at all times.

3.02 PROTECTION DURING CONSTRUCTION

- A. Throughout this Contract, provide protection for materials and equipment against loss or damage in accordance with provisions elsewhere in these Contract Documents. Throughout this Contract, follow manufacturers' recommendations for storage. Protect all equipment from the effects of weather.
- B. Prior to installation, store items in clean, dry, indoor or other locations suitably protected from the elements. Energize all integral equipment space heaters with temporary power as required. Provide temporary heating devices, sufficient to prevent condensation, for all other electrical equipment that does not have space heaters.
- C. Following installation, protect materials and equipment from corrosion, physical damage, and the effects of moisture on insulation. When equipment intended for indoor installation is installed at the Contractor's convenience in areas where it is subject to dampness, moisture, dirt, or other adverse atmosphere until completion of construction, ensure that adequate protection from these atmospheres is provided. Such protection methods shall be approved by the Engineer.
- D. Cap all conduit runs during construction with manufactured seals until installation of conductors is required. Keep openings in boxes or equipment closed during construction.

3.03 SERVICE CONTINUITY

- A. Maintain continuity of electric service to all functioning portions of the plant. Make no outages without prior written authorization of the Engineer. Include all costs for temporary

wiring and overtime work required in the Contract price as required to meet the Project constraints defined in Division 1. Remove all temporary wiring at the completion of the work.

- B. Provide temporary electric power used during construction including the use of standby generators for continuous operation as needed as required under Division 1.

3.04 EQUIPMENT IDENTIFICATION

- A. Provide identification nameplates for all electrical and instrumentation equipment provided under this Contract. Provide nameplate designations as shown on the Drawings and as specified herein.
- B. Nameplates shall be screw mounted to NEMA 1 enclosures. Nameplates shall be bonded to all other enclosure types using an epoxy or similar permanent waterproof adhesive. Two sided foam adhesive tape is not acceptable. Where the equipment size does not have space for mounting a nameplate the nameplate shall be fastened to the equipment using stainless steel wire or jack chain or permanently fastened to an adjacent mounting surface as directed by the Engineer.

3.05 EQUIPMENT SUPPORTS

- A. Provide equipment supports for all equipment in accordance with the mounting and anchorage requirements of Section 01 61 20 and per manufactures requirements.
- B. Installation of equipment shall not proceed until mounting and anchoring calculations have been submitted and approved.
- C. Free standing panels and enclosures shall be mounted on concrete pads having plan dimensions shown on the Drawings or larger if required by the mounting and anchorage calculations.

3.06 SLEEVES AND FORMS FOR OPENINGS

- A. Provide and place all sleeves for conduits penetrating floors, walls, partitions, etc. Locate all slots for electrical work and form before concrete is poured.
- B. Identify precise locations for stubbing-up and terminating concealed conduit prior to commencing conduit layout work. Obtain shop drawings and templates from equipment vendors or other subcontractors and properly locate the concealed conduit before the floor slab is poured.
- C. Where setting drawings are not available in time to avoid delay in scheduled floor slab pours, the Engineer may allow the installations of such conduit to be exposed. Requests for this deviation must be submitted in writing. No additional compensation for such change will be allowed.
- D. Seal all openings, sleeves, penetration and slots as specified in Section 26 05 33.

3.07 CUTTING AND PATCHING

- A. Lay out work carefully in advance. Do not cut, drill, or notch any structural member or building surface without specific approval of Engineer. Carefully carry out any cutting,

channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment.

- B. Following cutting and patching work, restore surfaces to original finished condition. Include all patching and painting of the surfaces to match original. Use skilled craftsmen of the trades involved.

3.08 LOAD BALANCE

- A. The Drawings and Specifications indicate circuiting to electrical loads and distribution equipment. Balance electrical load between phases as nearly as possible on lighting and distribution panelboards, etc. based on the load requirements of the actual equipment provided under this Contract.

3.09 TESTS

- A. Perform testing as specified in Section 26 08 00.

3.10 CLEANUP AND PAINTING

- A. The Contractor shall be responsible for the removal and legal disposal of all debris and unused equipment which he introduces to the project site during the execution of the Contract.
- B. Painting shall be in accordance with Section 09 90 00. Unpainted boxes, cabinets, and raceways mounted on walls that are painted or to be painted shall be painted the same color as the walls.
- C. Keep the premises free from accumulation of waste material or rubbish. Upon completion of work, remove all materials, scraps, and debris from premises and from interior and exterior of all devices and equipment.
- D. Touch up scratches, scrapes, or chips in interior and exterior surfaces of devices and equipment with finishes matching as nearly as possible the type, color, consistency, and type of surface of the original finish. If extensive damage is done to equipment paint surfaces, refinish the entire equipment in a manner that provides a finish equal to or better than the factory finish, that meets the requirements of the Specifications, and that is acceptable to the Engineer.
- E. The interior of all electrical equipment, including windings of dry type transformers, shall be vacuumed and wiped free of dust, metal filings, and other debris. Cleaning shall be done prior to energization and again immediately before final inspection. De-energization of any equipment that is required to allow panel cleaning shall be approved in writing by the Engineer.
- F. Refer to Section 01 74 23 and the individual equipment technical specifications of Division 26 for additional requirements.

3.11 MANUFACTURER'S SERVICE AND TRAINING

- A. Provide manufacturer's services for equipment installation, startup, and testing. Provide training of plant personnel in operation and maintenance of the equipment furnished under other Sections of Division 26 and as specified in **Section 01 79 00**.

3.12 INSPECTION

- A. Allow materials, equipment, and workmanship to be inspected at any time by the Engineer and Owner or their representatives. Correct work, materials, or equipment not in accordance with these Contract Documents or found to be deficient or defective in a manner satisfactory to the Engineer.
- B. Before request for final inspection is made, the Contractor shall submit to the Construction Manager, in writing, a certificate stating that the Contractor has made his own thorough inspection of the entire project and that the installation is completed and in conformance with the applicable codes, and the contract plans and specifications.

END OF SECTION

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SECTION 26 05 19

LOW VOLTAGE CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work Included: This section covers furnishing and installing low voltage cable systems as specified herein, complete, and in operating condition.
- B. Conduit Schedules indicating conductor number and minimum required conductor sizes are shown on the Drawings. The Schedules are prepared as a guide to the Contractor and additional circuits from home runs, specialty manufactured cables, and supplier specific wiring may require additional conductors not specifically included in the schedule. Such omissions in the Schedules shall not relieve the Contractor of the responsibility of furnishing and installing the necessary cables and raceways as required by the remainder of the Contract Documents for a fully functioning and operational system.

1.2 RELATED SECTIONS:

- 1. Section 26 05 00 – Common Work Results for Electrical.

1.3 SUBMITTALS

- A. Submittals shall be made in accordance with Section 01 33 00 and Section 26 05 00.
- B. Submit catalog data indicating manufacturer, insulation designation, and ratings in sufficient detail to determine conformance with these specifications:
 - 1. Power, control, and instrumentation wire.
 - 2. Termination and splicing materials.
 - 3. Pulling lubrication compound.
 - 4. Circuit identification system.
- C. Submit results of field testing for new conductors provided under this Contract and for existing conductors tested under this Contract as noted on the Drawings and as specified in Section 26 08 00.
- D. **OPTIONAL** - Submit, in accordance with Section 01 33 00, samples of proposed wire. Each sample shall have the size, type of insulation and voltage stenciled on the jacket. Approved samples will be sent to the project location for comparison by the Resident Engineer with the wire actually installed.
- E. **OPTIONAL** - Submit pulling calculations for all low voltage cables installed in concrete ductbanks showing compliance with all manufacturer's recommended installation requirements and pulling tensions. Submittal shall include the recommended sequence of cable installations specifically detailing the "from" and "to" points for each cable installation segment.

1.4 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. B-3 - Standard Specification for Soft or Annealed Copper Wire.
 - 2. B-8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

3. B-33 – Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.
- B. International Cable Engineers Association (ICEA).
1. S-95-658 – Non-Shielded Power Cable Rated 2000V or less
 2. S-61-402 – Thermoplastic Insulated Wire and Cable for Transmission and Distribution
- C. National Fire Protection Association (NFPA):
1. NFPA 70 – National Electrical Code (NEC).
- D. National Electrical Manufacturers Association (NEMA):
1. NEMA WC 3, Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
 2. NEMA WC 5, Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
 3. NEMA WC 7, Cross-Linked- Thermosetting- Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
- E. Telecommunications Industry Association (TIA)
1. EIA-568-B.2-1 – Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted-Pair Cabling Components
- F. Underwriters Laboratory (UL):
1. Standard 44 – Thermoset Insulated Wires and Cables.
 2. Standard 83 – Thermoplastic Insulated Wires and Cables.
 3. Standard 444 – Communications Cables
 4. Standard 510 – Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.
 5. Standard 1277 – Standard for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members
 6. Standard 1569 – Standard for Metal-Clad Cables
 7. Standard 1581 – Reference Standard for Electrical Wires, Cables and Flexible Cords.
 8. Standard 1666 – Standard for Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
 9. Standard 1685 – Standard for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables

1.5 CONDUCTOR COLOR CODING

- A. Color coding of multiconductor control and instrumentation cable is specified in the individual cable type specification.
- B. For power conductors, provide all single conductors and individual conductors of multiconductor power cables with integral insulation pigmentation of the designated colors, except conductors larger than No. 6 AWG may be provided with color coding by wrapping the conductor at each end and at all accessible locations with vinyl tape. Where this method of color coding is used, wrap at least six full overlapping turns of tape around the conductor covering an area 1 1/2 to 2 inches wide at a visible location at all conductor termination and pulling points.

- C. Phase A, B, C implies the direction of positive phase rotation.
- D. Mark conductors using the following colors for power conductors.

System	Conductor	Color
All Systems	Equipment Grounding	Green
120/240 Volts, 1-Phase, 3-Wire	Line 1 Line 2 Neutral	Black Red White
208Y/120 Volts, 3-Phase, 4-Wire	Phase A Phase B Phase C Grounded Neutral	Black Red Blue White
480Y/277 Volts, 3-Phase, 4-Wire	Phase A Phase B Phase C Grounded Neutral (if used)	Brown Orange Yellow White, Black Tracer

- E. All conductors carrying AC foreign voltage over 100 Vac into control panels, switchboards, and other enclosures shall be yellow. Multi-conductor cables carrying such foreign voltage shall be marked with yellow tape at each termination point.

1.6 DELIVERY, STORAGE AND HANDLING

- A. The Contractor shall inspect the reels as they are unloaded from the delivery truck, any visible damage shall be reported by the Contractor and the reel returned to the factory.
- B. The Contractor shall provide a crane, special lift truck or forklift suitably rated to unload the cable reels.
- C. Cables shall be packaged on spools or reels. Each package shall contain only one continuous length of cable. The packaging shall be constructed so as to prevent damage to the cable during shipping and handling.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. General
 - 1. All wire and cable conductors shall be annealed soft drawn copper with 98% conductivity. Aluminum conductors are not acceptable and shall not be used.
 - 2. Provide Class B stranded conductors in all cases except that wiring for lighting and receptacle circuits may be solid.
 - 3. Conductors shall be in accordance with applicable NEMA standard WC 70. All conductors shall be UL Listed.
 - 4. All conductors installed in tray shall be tray rated (Type TC) and run without splices in and out of the cable trays.
 - 5. All conductors shall have ampacity ratings at 90° C in dry locations and 75° C in wet location minimum in accordance with the NEC unless noted otherwise.

6. Conductor sizes shown on the Drawings or schedules shall be the minimum size provided regardless of the type of conductor used.
 7. Wire smaller than No. 12 AWG shall not be used for power feeders. Wire smaller than No. 12 AWG shall only be used for control, signal and instrumentation circuits,
- B. 600 Volt Single Conductor Power and Building Wire
1. Provide type XHHW/XHHW-2 insulation for power conductors No.12 and larger
 2. Wire for circuits over 150 Volts to ground shall be NEC type XHHW/XHHW-2 for sizes 4/0 AWG and smaller and shall be NEC type RHW for sizes 250 kcmil and larger as manufactured by the Okonite Co.; Carol Cable Co. Inc.; Pirelli Cable Corp. or approved equal.
- C. Single conductor power wiring for circuits 600 volts and below shall be NEC type XHHW/XHHW-2 insulation for sizes up to No. 4/0 AWG. Single conductor power wiring for circuits 600 volts and below shall be either NEC type XHHW-2 or Type DLO NEC Type RHW/RHH insulation for sizes 250 kcmil or larger.
1. Wire for lighting and receptacles not exceeding 150 Volts to ground shall be NEC type THHN/THWN as manufactured by the Okonite Co.; Carol Cable Co. Inc.; Pirelli Cable Corp. or approved equal.
 2. Acceptable Manufactures:
 - a. Okonite, X-Olene
 - b. Southwire
 - c. General Cable
 - d. Approved equal
- D. Single Conductor Control, Status, and Alarm Wire
1. Single conductor wiring shall be 600V, No.14 AWG NEC type XHHW/XHHW-2 and type MTW inside control panels as manufactured by the Okonite Co.; Carol Cable Co. Inc; Pirelli Cable Corp. or equal.
- E. Variable Frequency Drive (VFD) Cable 600V and Less.
1. For installation in conduits between VFD and motor.
 2. Three stranded XLPE insulated circuit conductors with full size insulated tinned copper ground conductor and full size stranded tinned copper drain wire.
 3. Jacket shall be oil resistant and sunlight resistant PVC type.
 4. 100% overall aluminum shield and 85% braid coverage.
 5. Provide cable that is UL listed and tray rated conforming to the requirements of UL 1277 and NEC Type TC.
 6. Acceptable Manufactures:
 - a. Belden
 - b. Alpha Wire
 - c. Approved equal
- F. Variable Frequency Drive (VFD) Cable 600V and Less.
1. For installation in cable tray and exposed environment between VFD and motor.
 2. Three stranded copper XLPE insulated circuit conductors with three symmetrical ground conductors.

3. Jacket shall be sunlight resistant PVC type.
 4. Continuous corrugated aluminum armor shall provide protection against moisture, liquids and gases.
 5. Provide cable that is UL listed and tray rated conforming to the requirements of UL 1569 and NEC Type MC.
 6. Acceptable Manufactures:
 - a. Okonite – C-L-X
 - b. South Wire – MC-HL
 - c. Approved equal
- G. Multi Conductor Power, Control, and Instrumentation Cable 600 Volts and Less:
1. General: Provide cable that is UL listed and conforms to the requirements of the NEC Type TC, or UL listed Power Limited Circuit Cable that conforms to the requirements of Article 725 of the National Electrical Code where applicable. Provide cables permanently and legibly marked with the manufacturer's name, the maximum voltage rating for which the cable was tested, the type of cable, and labeled UL (or submit evidence of UL listing).
 2. 600 Volt Multi-Conductor Power Cable
 - a. Cable shall be 3- or 4- insulated conductors with overall jacket. Cable assembly shall include bare copper equipment grounding conductor as indicated on the Drawings or Schedules.
 - b. Cable shall be rated and suitable for installation in open air, cable trays, conduit, wireway, direct burial or other approved raceways. Minimum cable temperature rating 90 degrees C dry and wet locations.
 - c. Conductors shall be Class B stranded copper, insulated with cross-linked polyethylene jacket, listed per UL 1581 as XHHW-2. Outer jackets shall be flame resistant, sunlight- and oil-resistant PVC.
 - d. Conductors shall meet or exceed the requirements of UL 1277 and ICEA S-95-658.
 - e. Color code the conductor groups in accordance with ICEA S-61-402, Appendix K, Method 1, E 2.
 - f. Acceptable Manufacturers:
 - 1) Okonite, - X-Olene
 - 2) Southwire
 - 3) General Cable
 - 4) Approved equal.
 3. 600 Volt Multi Conductor Control Cable
 - a. General: Multi conductor control circuit interconnection cable with integral ground. Suitable for installation in open air, cable tray, conduit, wireway, direct buried or other approved raceways. Minimum cable temperature rating 90 degrees C dry and wet locations. Provide cable with size and number of conductors as shown on the Drawings or Schedules
 - b. Individual Conductors: Class B stranded copper per ASTM B-8.

- c. Insulation and Jackets: Provide cross linked polyethylene insulated conductors UL listed per UL 1581 as Type XHHW-2. Outer PVC jacket shall be flame resistant, sunlight and oil resistant.
 - d. Color code the conductor groups in accordance with ICEA S-61-402, Appendix K, Method 1, E 2.
 - e. Acceptable Manufacturers:
 - 5) Okonite – X-Olene
 - 6) Southwire
 - 7) General Cable
 - 8) Approved equal
4. 600 Volt, Twisted, Shielded Pair Instrumentation Cable:
- a. General: Type TC, single pair instrumentation cable designed for noise rejection for process control, computer, or data log applications. Suitable for installation in conduit, wireway, or other approved raceways. Minimum cable temperature rating shall be 90°C dry locations, 75°C wet locations.
 - b. Individual Conductors: No. 16 AWG stranded bare annealed copper, Class B, 7 strand concentric per ASTM B-8, size as indicated on the drawings; 7 strand tinned copper drain wire.
 - c. Insulation and Jacket: Each conductor 15 mil nominal PVC and 4 mil nylon insulation. Pair conductors pigmented black and red. Jacket flame retardant and sunlight and oil resistant PVC with 45 mil nominal thickness. Aluminum/polyester shield overlapped to provide 100 percent coverage.
 - d. Acceptable Manufacturers:
 - 9) Belden No. 9342
 - 10) Alpha Wire Company
 - 11) Okonite
 - 12) Approved equal
5. 600 Volt Multi twisted Shielded Pairs with a Common Overall Shield Instrumentation Cable:
- a. General: Type TC, twisted, shielded pairs of instrument cables, grouped in a single cable, designed for use for instrumentation, process control, and computer applications. Suitable for installation in conduit, wireway, or other approved raceways. Minimum cable temperature rating shall be 90°C dry and wet locations.
 - b. Conductors: No. 16 stranded bare annealed copper, Class B, 7 strand, concentric per ASTM B-8. Tinned copper drain wires sized as shown on the Drawings, one for each pair and one for the overall group.
 - c. Insulation and Jacket: Each conductor 15 mil PVC and 4 mil nylon insulation Outer jacket flame retardant and sunlight and oil resistant PVC with 45 mil minimum thickness. Individual pair shield aluminum/polyester. Group shield aluminum/polyester, overlapped for 100 percent coverage.
 - d. Pair conductors pigmented black and red or black and white, with red or white conductor numerically printed for group identification.
 - e. Acceptable Manufacturers:

- 1) Belden No. 1041A
- 2) Okonite
- 3) Approved equal

H. Category 6 Unshielded Twisted Pairs:

1. General: industrial grade Category 6 Unshielded Twisted Pairs (UTP) suitable for use in harsh environments as industrial Ethernet cable, 600 MHz Enhanced Category 6, Gigabit Ethernet, 100BaseTX, NTSC/PAL Component or Composite Video, RS-422, RJ-45 compatible, suitable for outdoor use and installation in conduit and other approved raceways.
1. Conductors: 4 pairs of conductors, 8 conductors total, 23 AWG solid bare copper conductors.
2. Insulation and Jacket: polyolefin insulation, individual conductors colored white/green and green, white/orange and orange, white/blue and blue, and white/brown and brown, center strength member, unshielded, industrial grade sunlight and oil resistant PVC jacket, outer jacket ripcord, 0.251 x 0.339 inch overall nominal diameter, 300 volts, -40 degrees C to +75 degrees C operating temperature.
3. Applicable Standards: NEC/UL CMR, UL Style 444, ANSI/TIA/EIA-568-B.2-1 CAT 6, UL Verified to Category 6, UL 1666 Riser Flame Test.
4. Acceptable Manufacturers:
 - a. Belden 7927A
 - b. Approved equal

I. 6/C RS-485:

1. General: industrial low-capacitance shielded cables for EIA RS-485 applications, including security access card readers, suitable for outdoor use and installation in conduit and other approved raceways.
2. Conductors: 3 pairs of conductors, 6 conductors total, 22 AWG, 7 strand tinned copper conductors.
3. Insulation: foam high density polyethylene insulation, pairs colored white/blue and blue/white, white/orange and orange/white, white/green and green/white.
4. Shield: aluminum foil polyester tape providing 100 percent coverage, tinned copper braid providing 90 percent coverage, 7-strand tinned copper 24 AWG drain wire.
5. Jacket: UV and oil resistant PVC, 0.420 inch overall nominal diameter, 300 volt, -20 degrees C to +60 degrees C operating temperature.
6. Applicable Standards: NEC/UL CM and PLTC OIL RES II, UL 1685 Flame Test, UL 1581 Sunlight Resistance Test.
7. Acceptable Manufacturers:
 - a. Belden 3108A
 - b. Approved equal

J. Category 6A Nonbonded-Pair Cable:

1. General: Category 6A Unshielded Twisted Pairs (UTP) suitable for use as premise horizontal cable, both plenum rated and riser rated, 10 Gigabit Ethernet cable, 100BaseTX, 100BaseVG ANYLAN, 155ATM, 622ATM, NTSC/PAL Component or

Composite Video, AES/EBU Digital Audio, AES51, RS-422, noisy environments, PoE, suitable for installation in conduit and other approved raceways.

2. Conductors: 4 pairs of conductors, 8 conductors total, 23 AWG solid bare copper conductors.
 3. Insulation and Jacket: polyolefin insulation, individual conductors colored per TIA 568B Standard color code, center strength member, unshielded, industrial grade sunlight and oil resistant PVC jacket, outer jacket ripcord, 0.295 inch overall nominal diameter, 300 volts, -20 degrees C to +60 degrees C operating temperature.
 4. Performance: 10 Gigabit Ethernet across a 500 MHz frequency range.
 5. Applicable Standards: NEC/UL CMR, TIA 568-C.2, ISO/IEC 11801 Class EA, UL 1666 Vertical Riser Flame Test.
 6. Acceptable Manufacturers:
 - a. Belden 10GX
 - b. Mohawk XGO F/UTP
 - c. Approved equal
- K. Industrial Ethernet Passive Components:
1. Provide connectors, sockets, and couplings suitable for use in industrial Ethernet applications for 10 Gigabit Ethernet data transmission.
 2. Components shall be rated for IP20 and IP67 class of protection in accordance with IEC 529.
 3. Equipment shall be designed to withstand harsh industrial environments including high temperatures and damp locations. Housings shall be resistant to dirt and liquids.
 4. Applicable Standards: NEC/UL CMR, TIA 568-C.2, ISO/IEC 11801 Class EA, UL 1666 Vertical Riser Flame Test.
 5. Acceptable Manufacturers:
 - a. Phoenix Contact PLUSCON data
 - b. Weidmuller Steady Tec
 - c. Approved equal
- L. Flexible Cords, Cables, and Fittings:
1. Where flexible cords and cables are required, provide Type SO, 600-volt, having the number and size of copper conductors shown on the Drawings.
 2. Provide liquid-tight strain relief fittings for exposed flexible cord and power cable where cables enter electrical panels and enclosures. Provide strain relief as manufactured by Hubbell (Kellums), OZ Gedney, or approved equal
- M. Electrical Tape for Color Coding:
1. Electrical tape shall be premium grade, not less than 7 mils thick, rated for 90 degree C minimum, flame-retardant, weather resistant, and available in suitable colors for color coding. The tape shall be resistant to abrasion, ultraviolet rays, moisture, alkalies, solvents, acids, and suitable for indoor and weather-protected outdoor use. The tape shall be suitable for use with PVC and polyethylene jacketed cables, and meet or exceed the requirements of UL 510.

2. Acceptable Manufactures:
 - a. 3M 35 Scotch Vinyl Electrical Tape for Color Coding
 - b. Plymouth Rubber Company Premium 37 Color Coding Tape
 - c. Approved equal

- N. Arc and fireproofing tape: Arc and fireproofing tape shall consist of a flexible conformable unsupported elastomer. The tape shall be not less than 30 mils (0.030 inches) thick and be capable of over 100 percent elongation. The tape shall be non-corrosive to metallic cable sheaths and compatible with synthetic cable jackets such as Hypalon (CSPE) and PVC. The tape shall be self-extinguishing and shall not support combustion. The tape shall not deteriorate when subjected to water, salt water, gases, and sewage.
 1. Acceptable Manufactures:
 - a. 3M Scotch 77 Fire and Arc Proofing Tape.
 - b. Plymouth Rubber Company 53 Plyarc Arc and Fire Proofing Tape.
 - c. Approved equal

- O. Low Voltage Splices, 600 volts and below:
 1. Power Conductors
 - a. General: Provide low voltage splices consisting of 600 volt compression type connectors and connector insulators, suitable for indoor and outdoor field installations.
 - b. Provide two way, uninsulated, compression connectors, long barrel type, suitable for use with stranded copper conductors. Provide UL listed connectors rated 600 volts minimum. Acceptable manufacturers: Burndy, Thomas and Betts, Panduit, or approved equal.
 - c. Connector insulators shall be cold shrink type factory expanded and assembled tubular EPDM rubber sleeves, suitable for field installation. Insulators shall shrink over in line connections, forming a water proof seal. Provide insulators rated for 1000 volts, minimum.
 - d. Acceptable manufacturers:
 - 1) 3M
 - 2) Approved equal
 2. Control Conductors
 - a. Insulated compression type connectors shall be of the expanded vinyl insulated parallel or pigtail type as manufactured by Ideal Industries; 3M Co.; Panduit Corp. or approved equal.
 - b. Solderless pressure connectors shall be self-contained, waterproof and corrosion-proof units incorporating prefilled silicone grease to block out moisture and air. Connectors shall be sized according to manufacturer's recommendations. The connectors shall be UL listed and CSA approved, as manufactured by King Technology, St Louis, MO; Ideal Industries, Inc., Sycamore, IL or approved equal.

- P. Low Voltage Terminations, 600 volts and below:
 1. Power Conductors
 - a. Provide solderless, die type or set screw compression type lugs and connectors. Provide plated copper alloy terminations as manufactured by

Thomas and Betts; Burndy; or approved equal. Provide lugs and connectors recommended by the manufacturer for the cable type used.

- b. Motor connections shall be screw type insulated pressure connections terminations installed on the branch circuit wires and the motor leads and secured with bolt, nut and springwasher. Provide insulation by heat shrink boot especially made for motor termination use. Wire nuts, split bolts, etc., are not acceptable. Connections shall be insulated with a Raychem Type MCK, roll-on stub insulator or approved equal and shall be as recommended by the manufacturer for the cable type used.

2. Control, Status, and Alarm Conductors

- a. Termination connectors shall be of the locking fork-end (upturned leg ends) type as manufactured by Ideal Industries; 3M Co.; Panduit Corp. or approved equal.

3. Instrumentation Cables

- a. Termination connectors shall be of the locking fork-end (upturned leg ends) type as manufactured by Ideal Industries; 3M Co.; Panduit Corp. or approved equal.

Q. Wire and Cable Markers

1. Wire and cable markers shall be pre-printed, clip sleeve type as manufactured by the W.H. Brady Co.; Thomas & Betts Co.; 3M Co. or approved equal.
2. Wire and cables with diameters exceeding the capacity of the clip sleeve type shall be marked with pre-printed, self-adhesive vinyl tapes as manufactured by the W.H. Brady Co.; Panduit Corp. or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

- A. Use lubrications to facilitate wire pulling. Lubricants shall be UL approved for use with the insulation specified.
- B. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii. Pulling of cable shall be performed in such a manner that the cable outer jacket does not scrape against the edge of the conduit, at both the inlet and outlet ends of the conduit. Cable shall be free of sandy or gritty material during pulling. If cable is laid on ground during pulling, cable shall be wiped free of sandy or gritty material prior to entry of cable into conduit and prior to application of any pulling compound.
- C. Tighten all screws and terminal bolts using torque type wrenches and/or drivers to tighten to the inch pound requirements of the NEC and UL.
- D. Where single conductors and cables enter manholes, handholes, vaults, and other indicated locations bundle the conductors from each conduit throughout their exposed length with nylon, self locking, releasable, cable ties placed at intervals not exceeding 18 inches on centers.
- E. Wrap exposed lengths of 480V feeders in manholes or handholes, #4/0 and higher, with fire resistant tape.
- F. Terminate no more than two control conductors per terminal point. Terminate all spare conductors on terminal blocks.
- G. When pulling low voltage power and control conductors in the same conduit, only combine conductors with no more than two wire sizes difference to prevent possible installation damage to the smaller conductors; otherwise use separate conduits.

- H. Uniquely identify all wires, cables and each conductor of multi-conductor cables (except lighting and receptacle wiring) at each end with approved wire and cable marker systems as specified herein.
- I. Submit a schedule of cable pulls 2 weeks prior to installation and certify in writing that the cable will meet the requirements of the cable manufacturer for maximum pulling tension, allowable sidewall pressure, and installed bending radius limitations.
- J. Monitor pulling tensions while pulling on runs between manholes and handholes and record the maximum tensions used. Advise the Engineer of cases exceeding the manufacturer's recommendations and remove and replace cables subjected to tensions in excess of those recommended.

3.2 CONDUCTOR 600 VOLTS AND BELOW

- A. Provide conductor sizes indicated on drawings with no splices except as approved in writing by the Engineer.
- B. Wire nuts may be used only on 120 volt lighting and 120 volt receptacle circuits. Place no more than one conductor in any single-barrel pressure connection. Use crimp connectors with tools by same manufacturer and/or UL listed for connectors of all stranded conductors. Soldered mechanical joints insulated with tape will not be acceptable.
- C. Color coding on wire sizes larger than No. 6 AWG shall be by taping the individual conductors with the appropriate colored self adhesive vinyl electrical tape.
- D. Provide terminals and connectors recommended by the manufacturer for the type of material used.
- E. Arrange wiring inside control panels, motor starters, switchgear, etc., neatly cut to proper length, remove surplus wire, and bridle and secure in an acceptable manner. Identify all circuits entering switchgear, motor starters, control panels, etc., in accordance with the cable schedules on the drawings. Terminate cable conductors on the same side of the terminal blocks as shown on the drawings.
- F. Terminations for power conductors shall be die type or set screw type pressure connectors as specified. Splices for power conductors if specifically requested by the Contractor and approved in writing by the Engineer, shall be die type compression connector and waterproof with shrink fit rubber boot (as specified) or epoxy filling for copper conductors # 4 AWG and larger. Splices shall be solderless pressure connectors with insulating covers for copper conductors # 6 AWG and smaller. Approved splicing shall be performed only in enclosures approved for splicing in the NEC.
- G. Terminate control and instrumentation wiring with methods consistent with terminals provided, and in accordance with terminal manufacturer's instructions. Where terminals provided will accept such lugs, terminate all control and instrumentation wiring (except solid thermocouple leads) with insulated, locking fork compression lugs. Control panel incoming field wireway sizes indicated on the Drawings are considered minimum. Contractor shall adjust wireway sizes to meet NEC percentage fill requirements.
- H. For terminals designed to accept only bare wire compression terminations use only stranded wire and terminate only one wire per terminal. Tighten all terminal screws with torque screwdriver to recommended torque values.
- I. For control and instrumentation cables use ferrule on ends of wire. For cables terminating on terminal blocks, also use ferrule type.
- J. Attach compression lugs with a tool specifically designed for that purpose which provides a complete, controlled crimp where the tool will not release until the crimp is complete. Use of plier type crimpers is not acceptable.

- K. Where conductors pass through holes or over edges in sheet metal, remove all burrs, chamfer all edges, and install bushings and protective strips of insulating material to protect the conductors.
- L. For conductors that will have final terminations by Others, provide at least six feet spare conductor in freestanding panels and at least two feet spare in other assemblies. Provide sufficient spare conductor length in any particular assembly as required to reach the termination point plus an additional two feet of slack conductor.
- M. Cables passing through manholes and handholes shall be trained along the walls on cable racks. Allow two feet of slack in each run in a "drip loop" at least once along a wall. Loops and cables shall be organized, trained, bundled, and neatly installed.
- N. Do not strip cables more than eight inches from the nearest termination point of that cable.
- O. Cap spare conductors and conductors not terminated with UL listed end caps.
- P. All spare pairs shall be bundled and labeled with the cable designation. All individual pairs shall be tagged to enable identification of spare pairs when making future terminations.
- Q. Splices will not be permitted except as accepted in writing by the Engineer.
- R. Ends of cable shall not be exposed to the ambient environment more than 24 hours after pulling or splicing. After 24 hours the cable shall be purged with nitrogen or sealed with tape.

3.3 INSTRUMENTATION CABLES 600 VOLTS AND LESS

- A. All circuits shall be installed as twisted pairs or triads. In no case shall a circuit be made up using conductors from different pairs or triads. Triads shall be used wherever three wire circuits are required.
- B. Terminal blocks shall be provided at all instrument cable junction and all circuits shall be identified at such junctions. Direct splicing of signal and instrumentation circuits is not acceptable. Shielded instrumentation wire, coaxial, data highway, I/O and fiber optic cables shall be run without splices between instruments, terminal boxes, or panels.
- C. Shields shall be grounded as recommended by the instrument manufacturer and isolated at all other locations. Terminal blocks shall be provided for inter-connecting shield drain wires at all junction boxes. Where individual circuit shielding is required, each shield circuit shall be provided with its own block.

3.4 LACING OF WIRES AND CABLES

- A. All wires and cables shall be laced in pull or junction boxes, manholes, handholes, wireways, and at each termination. Wires and cables shall be laced so that the wires of the individual circuits are laced together by circuit and the laced together circuit or cable shall be tagged with the cable number. All wiring entering and exiting the control panels or pull structure shall be bundled into groups. Power, lighting, control, alarm, and instrumentation wiring shall be bundled and laced as specified herein.

3.5 FIELD QUALITY CONTROL

- A. Provide acceptance testing of all of the low voltage cables per Section 26 08 00.
- B. Coordinate system loop checking including point to point cable continuity checking and verification in conformance with the requirements of Section 40 61 00.
- C. All data highway and special systems cabling shall be tested as required by the system manufacturer requirements. Testing shall be performed as specified in the individual Division 40 or Division 26 sections to verify satisfactory signal transmission and reception in conformance with manufacturer's published requirements.

3.6 SPARES

- A. Spares are not included in the Drawings or Schedule unless specifically noted. When not specifically noted in the Schedule, an allowance for spare circuits shall be made. Provide a minimum of 25% spare circuits (rounded up to the next whole number), but at least one, for all instrumentation, signal, control, and alarm circuits feeding multiple devices. Spare conductors are not required for a single circuit, or individual runs to a specific field device.
- B. Identify spare conductors with source location and other identifiers as shown on the Drawings. Provide a minimum of 5-feet of extra conductors for each spare circuit. Wrap excess conductor lengths, provide with plastic tie-wrap, and coil up in last pullbox location of the run.

END OF SECTION

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SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work included:

1. Furnish all labor, materials, equipment, and incidentals required and install a complete grounding system in strict accordance with Article 250 of the NEC, as shown on the Drawings and as specified herein.
2. All raceways, conduits and ducts shall contain equipment grounding conductors sized in accordance with the NEC. Minimum sizes shall be No. 12 AWG.
3. Provide grounding bus bars where shown on the Drawings.

1.02 RELATED SECTIONS

1. Section 26 05 00 – Common Work Results for Electrical.
2. Section 26 08 00 – Commissioning of Electrical Systems.
3. Section 26 05 33 – Raceways and Boxes for Electrical Systems.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with Section 01 33 00 and Section 26 05 00.

B. Submit product data for the following:

1. Ground rods.
2. Ground rod boxes.
3. Exothermic welding materials and methods.
4. Mechanical and compression type grounding clamps including installation requirements and materials.
5. Grounding hubs and fittings.
6. Grounding bars
7. [Ground enhancement materials and methods including enhancement ground rods and enhancement grounding material. Submit calculations estimating the amount of enhancement material that will be required on this project.]

C. Submit results of grounding and bonding resistance testing as specified herein

D. [Shop drawings

1. Submit installation drawings showing locations of AC mitigation wires, buried ground rods, grounding connections, locations of embedded and buried grounding conductors, ground test stations, and locations of stub-ups and pigtailed for future connections to the grounding system.

2. Submit as-built drawings of the grounding system installation.
3. All drawings shall be dimensioned and include reference points, northing/easting coordinates, stationing, and other similar information necessary to locate buried and/or concealed grounding system infrastructure in the future.]

1.04 REFERENCES

- A. American National Standards Institute (ANSI)/ Institute of Electrical and Electronics Engineers (IEEE).
 1. IEEE Std 142 – IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems.
 2. IEEE Std 837 – IEEE Standard for Qualifying Permanent Connections used in Substation Grounding
- B. American National Standards Institute (ANSI)/National Science Foundation (NSF)
 1. ANSI/NSF 60 – Drinking Water Treatment Chemicals – Health Effects
- C. American Society for Testing and Materials (ASTM).
 1. ASTM B 3 – Standard Specification for Soft or Annealed Copper Wire.
 2. ASTM B 187 – Standard Specification for Copper Bar, Bus Bar, Rod, and Shapes.
 3. ASTM B 8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
- D. California Code of Regulations.
 1. Title 24, Part 3 – California Electrical Code (NEC), Article 250 (Grounding).
- E. Underwriters Laboratories (UL).
 1. UL 467 – UL Standard for Grounding and Bonding Equipment.
 2. UL 224 – UL Standard for Extruded Insulating Tubing.
- F. InterNational Electrical Testing Association (NETA).
 1. ATS – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- G. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A. All grounding and bonding products shall be UL listed.
- B. All exothermically welded or compression-type terminal lugs for buried or embedded connections shall use materials qualified in accordance with IEEE 837.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Direct-buried, concrete encased, and exposed grounding conductors.
 - 1. Bare concentric stranded copper conductors conforming to ASTM B-8 with Class B stranding, size as indicated on the Drawings.
 - 2. Acceptable manufactures:
 - a. Southwire
 - b. General Cable
 - c. Approved equal
- B. Ground rods
 - 1. 3/4 in by 8 [10]. [12] ft copper bonded steel constructed in accordance with UL 467. The copper thickness shall be 10 mil minimum, 15 mil average. Provide UL mark on ground rod.
 - 2. Acceptable manufacturers:
 - a. Eritech (Erico)
 - b. Approved equal
- C. Conduit grounding bushings
 - 1. Insulated, rated for 150° Celsius, malleable iron type with a solderless set-screw lug.
 - 2. Acceptable manufacturers:
 - a. Appleton
 - b. Hubbell Electrical Products (Raco)
 - c. Approved equal
- D. Waterpipe ground clamps
 - 1. Electroplated tinned bronze U-bolt style pipe clamp, sized as required for the pipe diameter and ground wire size specified.
 - 2. Acceptable manufacturers:
 - a. Harger
 - b. Blackburn (Thomas & Betts)
 - c. Approved equal
- E. VFD-Driven motor ground straps
 - 1. Provide high frequency ground straps for all inverter driven motors provided under this Contract.
 - 2. Provide flat-braided tinned-copper strap, with circular hole on one end sized as required for the motor frame foot mounting screw, and ring terminal on the other end. Length shall be as required based on the installation details.
 - 3. Provide straps as recommended by the manufacturer for the driven motor frames.

4. Acceptable manufacturers:

- a. AEGIS
- b. Panduit
- c. Approved equal

F. Grounding system connections

1. Buried, encased, or in areas where connections will be not be readily accessible after completion of construction.

a. Buried, encased, or otherwise inaccessible grounding connections shall be made with exothermic welds. Molds, cartridge materials, and accessories shall be as specifically recommended by the manufacturer of the molds for the types of items to be welded. Molds and powder shall be furnished by the same manufacturer.

b. Acceptable manufacturers:

- 1) Harger (Ultraweld)
- 2) Eritech (Erico)
- 3) Approved equal

a. Buried, encased, or otherwise inaccessible grounding connections shall be made with irreversible mechanical compression connectors.

b. Mechanical connections to reinforcing steel shall be made using UL 467 listed irreversible crimp compression copper connectors with the “run” and “tap” sizes as required for the reinforcing steel and cable size, respectively, specified. Connectors shall be factory prefilled with moisture inhibiting compound.

c. Specific type of connectors shall be selected to match the specific connection to be made. Mechanical compression connections shall only be installed using manufacturer’s recommended hydraulic presses and dies.

d. Acceptable manufacturers:

- 4) Harger
- 5) Blackburn (Thomas & Betts)
- 6) Burndy
- 7) Approved equal

2. Accessible connections to equipment, connections to exposed structural steel (e.g. steel columns), connections to reinforcing steel, connections made to ground rods located in ground rod boxes, and all other locations where the connections are readily accessible to maintenance personnel after completion of construction.

a. Mechanical connections to ground rods, equipment, structural steel, and other accessible connections shall be made using heavy duty, U-Bolt or two hole bolted copper or bronze clamps as required for the cable size used. U-Bolt and cap screws shall be stainless steel.

b. Specific type of connectors shall be selected to match the specific connections to be made (water pipes, building steel, etc.).

c. Acceptable manufacturers:

- 8) Harger

- 9) Blackburn (Thomas & Betts)
- 10) Burndy
- 11) Approved equal

- G. Pre-cast concrete boxes for ground-rod installation
 - 1. Provide where shown on the Drawings. Provide boxes with cast iron riser rings, and traffic covers inscribed "GROUND ROD". Provide H-20 traffic rated boxes and covers.
 - 2. Acceptable manufacturers:
 - a. Christy
 - b. Jensen Concrete Products
 - c. Approved equal
- H. Electrical joint inhibitor compound
 - 1. Use at all bolted grounding connections as a moisture and oxidizing seal.
 - 2. Acceptable manufacturers:
 - a. Sanchem Inc., NO-OX-ID (A-Special Electrical Grade)
 - b. Approved equal
- I. Manufactured Grounding Bus Bar: Grounding bus bar shall be a high conductivity copper alloy measuring 1/4-inch by 4-inches, minimum length of 12-inches or as shown on the Drawings. Bus shall be predrilled on 1-inch centers to accept grounding compression terminals bolted with brass bolts, nuts, and washers coordinated with the installation. Provide grounding bus bars by Burndy Type BBB; Chatsworth, or equal.

2.02 GROUND ENHANCEMENT SYSTEM

- A. Furnish and install [1][2][] [an] electrolytic grounding system[s] as manufactured by [Erico, Ground Enhancement Material (GEM)]; [Lyncole XIT Lyncole Grounding, Division of Lyncole Industries, Inc;] [Harger Lightning and Grounding] or approved equal.

NOTE: Amendment material – include if required

- 1. Ground enhancement material in its set form shall have resistivity of not more than 20 ohm-cm. Ground enhancement material shall be permanent and maintenance free. Recharging with salts or chemicals is not acceptable. Material shall retain its earth resistivity with time and not require the presence of moisture to maintain its conductivity.
- 2. Material shall set up firmly and dissolve or decompose. Material shall be non-hazardous in conformance with ANSI/NSF 60 and shall not pollute or contaminate the surrounding soil or water table.
- 3. Material shall be suitable for installation in a dry or slurry form.
- 4. Each rod shall have the appropriate number of bottom, middle and top sections as recommended by the manufacturer. Electrodes shall be Type K copper, 0.083-in nominal wall thickness, hollow tube, 2.125-inches O.D. The tube shall be permanently capped on top and bottom. Air breather holes shall be provided in the top and drainage holes in the bottom of the tube for electrolyte drainage into the surrounding backfill material.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Prepare and clean piping, rods, and conductors prior to exothermic welding in conformance with the specific requirements of the welding system.
- B. Do not allow water pipe connections to be painted. If the connections are painted, disassemble them and remake them with new fittings.

3.02 INSTALLATION

A. General

1. Bond all exposed steel building columns in new structures together and connect to the grounding electrode system as shown on the Drawings. Connections to exposed structural steel columns or other exposed structural element shall be made with mechanical connectors.
2. Grounding of the pipe systems shall be provided per the requirements of NEC and as shown on the Drawings.
3. Metal conduits stubbed into power distribution equipment, control panels, or other enclosure shall be terminated with insulated grounding bushings and mechanically bonded to the enclosure's ground bus. Size the bonding wire in accordance with the NEC, except that a minimum No. 12 AWG shall be used.
4. Each separate building or structure shall have a grounding electrode or grounding electrode system per the requirements of the NEC.
5. All equipment enclosures, motor and transformer frames, conduits systems, cable armor, exposed structural steel and all other equipment and materials required by the NEC to be grounded, shall be grounded and mechanically bonded in accordance with the NEC.
6. Care shall be taken to ensure good ground continuity, in particular between the conduit system and equipment frames and enclosures. Where necessary, jumper wires shall be installed.
7. Liquid tight flexible metal conduit shall have bonding jumpers. Bonding jumpers shall be external, run parallel (not spiraled) and fastened with plastic tie wraps.
8. Run grounding electrode conductors in the building concrete slab/wall or as slab/wall-embedded unless otherwise shown on the Drawings.
9. Ground cable penetrations through building exterior walls shall enter within 3 feet below finish grade and shall be prepared with a water stop. Unless otherwise indicated, the water stop shall include filling the space between stands with solder and soldering a 12-inch copper disc over the cable.
10. Install equipment grounding conductors with all feeders and branch circuits. Each circuit shall have a dedicated equipment grounding conductor from source to load without splicing or "tee tapping" (e.g., three different receptacle circuits in a common home-run conduit back to a lighting panelboard shall have three separate equipment grounding conductors back to the lighting panelboard).
11. Ground metallic poles supporting outdoor lighting fixtures to a supplemental grounding electrode (rod) in addition to the separate equipment grounding conductor run with the supply branch circuit.

12. Ground metallic masts supporting radio antennae to a supplemental lightning protection grounding rod in addition to the separate equipment grounding conductor incorporated into the antennae signal cable as shown on the Drawings.
13. Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with ground clamp connectors.
14. Mechanically bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters and HVAC equipment. Use braided-type bonding straps.
15. Install driven ground rods in manholes and handholes close to wall and set rod depth at 4 to 6-inches above finished floor. Protect ground rods with double wrapping of pressure-sensitive tape or heat shrunk insulating sleeve from 2-in above to 6-in below concrete floor with connections of grounding conductors fully visible and accessible. Seal floor opening with waterproof, non-shrink grout. Where ground rods are installed outside of manhole or handhole, provide a No. 4/0 AWG bare copper conductor from ground rod into manhole or handhole through a waterproof sleeve in the wall. The ground rod shall be connected to the duct bank grounding electrode conductor where available.
16. Concrete encased duct banks shall include a grounding electrode conductor. Duct bank grounding electrode conductors shall connect to the facility grounding electrode system, including the grounding system of all manholes and handholes.
17. Direct-burial grounding grid electrode conductors shall be installed at a minimum depth of 24 inches below subgrade unless otherwise shown on the Drawings. Care shall be exercised at cable crossings to avoid damage to the cable. Damaged cable shall be replaced with new cable.

B. Ground connections

1. Electric Motors and Electrical Equipment
 - a. Grounding conductors for motors and electrical equipment shall be connected by a solderless terminal and a 5/16-inch, minimum, bolt tapped to the motor frame or equipment housing.
 - b. Large motors (over 100 HP) and major equipment items shall have at least 2 ground-pad-type connections and shall be attached to the main ground-grid at a minimum of 2 locations. Unless otherwise specified, connections of conductors to the equipment shall be with NEMA type, 2-hole, bolt-on bar lugs, and connections shall be made in accordance with the manufacturer's printed recommendations.
 - c. Paint, dirt, or other surface coverings shall be completely removed at the connection points of grounding conductors so that good metal-to-metal contact is made.
 - d. After grounding connections are made, areas around the connection point shall be prepared and the coating system repaired in accordance with **Section 09000**. Surfaces shall be restored to their original condition before the grounding connections are made.
 - e. Ground connections to smaller motors or equipment may be made by fastening the terminal to a connection box.
 - f. Junction boxes shall be connected to the equipment grounding system with 0.375-inch silicon-bronze machine screws.

2. VFD-driven motors
 - a. Install high frequency grounding straps for all inverter driven motors. Install high frequency grounding straps per manufacturer's instructions.
 - b. Grounding straps for motors shall be connected by a circular punched hole on one end for installation around foot mounting screw of NEMA- or IEC-frame motor, and by a ring terminal on the other end bolted to the nearby ground grid. Provide strap length as required based on the installation conditions.
 - c. Ensure metal-to-metal contact at both terminations by removing paint or corrosion at the motor foot and ground location.
3. Ground transformer neutrals, UPS neutrals, generators, and other separately derived sources to the nearest grounding electrode system as shown on the Drawings. The grounding electrode conductor shall be sized in accordance with the NEC unless otherwise specified on the Drawings. The grounding conductor shall be running continuous to the neutral (X/O) connection or run via an intermediate exposed bus bar located as shown on the Drawing or field located with the approval of the Engineer.
4. When a neutral grounding resistor is used, the neutral conductor from the neutral point of the transformer to its connection point to the grounding resistor shall be fully insulated.
5. All grounding type receptacles shall be grounded to the outlet boxes with a No. 12 THWN/THHN/MTW green conductor connected to the ground terminal of the receptacle and fastened to the outlet box by means of a grounding screw.
6. Shielded power cables shall be grounded at each termination point as required by the equipment and cable manufacturers or shown on the Drawings.
7. Ground instrumentation cable shields at a single point inside of the control panel at the signal grounding bus bar, unless grounding at the device is specifically required by the instrument manufacturer. Grounding of instrumentation shields shall conform to the requirements of Section 40 61 00.
8. Ground data highway and network cables as required by the manufacturer of the communication equipment and per the requirements of Section 40 61 00.
9. Grounding electrode conductors shall be exothermically welded to the foundation reinforcing steel grid as shown on the Drawings.
10. Seal exposed connections between different metals with electrical joint inhibitor compound. All buried connections shall be cleaned and coated with electrical joint inhibitor compound before backfilling.
11. Bolted connections shall not be buried or embedded. For compression-type connectors, the tool for crimping shall emboss the die index number into the connector as the crimp is completed. Each compression-type connector shall have an inspection port for use in checking proper conductor insertion. Compression connections shall be installed in strict accordance with manufacturer's printed recommendations using tools and dies of the proper size and type for the conductors, lug, and grounding electrode.
12. Molds used for exothermic welding shall be new. The number of welds made per mold shall not exceed the manufacturer's published recommendations.
13. Where pipe flange or piping is grounded by means of a clamp or lug, the pipeline coating shall be repaired, except the grounding connection area, as shown on the project Drawings or as specified under Section 09000.

14. Intersections: Intersections of grounding cables shall be bonded together.
15. Grounding taps and ground rods shall be connected by separate bonds to the main ground mat.

C. Ground rods

1. Install grounding electrodes at locations shown on the Drawings.
2. Drive ground rods to the depth shown on the Drawings. Interconnect ground rods and other grounding system components with the grounding conductor size shown on the Drawings.
3. Where solid or stratified rock is encountered perform the following
 - a. The Contractor shall auger a hole 10.5-feet deep, unless otherwise shown, and at least 4 inches in diameter.
 - b. Ground rods shall be placed and supported centrally in the hole.
 - c. Water shall be poured to fill the hole to 1/3 depth.
 - d. A granular grade of Bentonite (or approved equal) shall be gradually poured into the hole.
 - e. Pouring of water and Bentonite material shall be alternated until the hole is filled.
 - f. Throughout pouring, the material shall be thoroughly mixed to eliminate voids and ensure proper compaction.
 - g. Premixing water and Bentonite material in a separate container for placement into the hole shall not be permitted.

D. Grounding Conductors

1. Unless otherwise specified, provide continuous, unspliced equipment grounding conductors.
2. Lay all underground grounding conductors slack within 10 feet from the footing and, where exposed to mechanical injury, protect by PVC schedule 40 conduit or other approved physical protection. If guards are steel pipe, or other magnetic material, electrically connect conductors to both ends of the guard. Make connections as specified in this Section.
3. Where grounding conductors extend beyond the perimeter of the building to site structures, the grounding electrode system shall be continuous and the grounding conductor shall be encased in concrete ductbanks. Provide a minimum 2 layers of Aqua Seal over the taped assembly.
4. Conductors to equipment enclosures/tanks shall be neatly run along the face of concrete footings or structural steel, following surfaces closely to the point of connection. Conductors shall be supported and secured with cable fasteners at intervals no greater than 5 feet.
5. Conductors shall be mechanically bonded to metallic enclosures at each end and to intermediate metallic enclosures such as pullboxes.
6. Grounding conductors shall be connected to grounding bushings on raceways.
7. Where equipment contains a ground bus, grounding conductors shall be extended and connected to that bus. The enclosure of the equipment containing the bus shall also be connected to the bus.

8. Expansion Fittings: To relieve shearing and pulling action at structural expansion joints, cables shall be run in expansion joint fittings as shown on the Drawings.
- E. Fasteners
1. Clean the connector and conductor surfaces with a wire brush or emery cloth to a shiny, bright surface. For plated surfaces, compatible solvent cleaning shall be used in order not to remove any portion of the plating.
 2. Immediately after cleaning, apply an oxide-inhibiting compound with suspended copper particles on the threads of the connectors, ground plate, bolts, and other hardware used for making mechanical grounded connections.
 3. All fasteners shall engage a minimum of four full threads for electrical connections and equipment mounting.
 4. All bolts shall be coated with electrical joint inhibitor compound.
 5. Torque fasteners to manufacturer's requirements and NETA specifications.
- F. Concrete-Encased Grounding Electrode (UFER ground):
1. Fabricate concrete encased grounding electrodes in accordance with NEC Article 250 using a minimum of 20-ft of bare copper conductor as shown on the Drawings but in no case smaller than #4 AWG. Where base of foundation is less than 20-ft in length, loosely coil excess conductor within base of concrete foundation, maximizing the surface area exposed to the concrete.
 2. Extend grounding conductor below grade and connect to building grounding grid, ground loop, or grounding electrode external to concrete. Bond the grounding conductor to nearest rebar available.
 3. Embedded rebar and concrete encased electrodes shall be tied to the ground loop by #4/0 cable using exothermic welds at each end of the cable.
 4. The electrode shall be encased by at least 2 inches of concrete and lay horizontally in concrete that is in direct contact with the earth. Concrete with insulation, vapor barriers, water proofing, or other films between the concrete and the earth is not considered to be in direct contact with the earth.
- G. In addition to those items specified to be grounded above, the following metallic items shall also be grounded using a minimum of No. 2 AWG wire:
1. Cable tray sections, fittings, and connected raceways shall be effectively bonded and grounded.
 2. Hatch frames.
 3. Manhole and handhole cover frames.
 4. HVAC equipment and duct work installed under **Division 15**.
 5. Stairs and ladders.
 6. Door frames for person access doors and rollup doors.
 7. Building sheathing and exposed vertical structural elements.
 8. Fences enclosing electrical equipment.
 9. Non-electrical metallic items in close proximity to exposed electrical equipment.
 10. Equipment platforms that support electrical equipment. The support shall be bonded to the electrical equipment and the ground grid.

11. Frames and railings supporting push-button stations, receptacles, instrument cabinets, and raceways carrying circuits to these devices.
 12. Handrails and guardrails: Handrails and guardrails shall be made electrically continuous with bond jumpers or welds at slip joints, as necessary.
- H. Grounding Enhancement Material: Install ground enhancement material at each electrode around the grounding electrode conductors and as shown on the Drawings.
1. Install enhancement rods in augured holes of the diameter and depth required to allow installation of the ground enhancement material
 2. Install ground enhancement material around each rod per manufacturer's published installation requirements.
 3. Material shall extend a minimum of 6-inches in all directions around the electrode unless otherwise shown on the Drawings.
 4. Material; shall extend from 8-inches below top of ground rod to bottom of rod.
- I. Grounding Enhancement Ground Rods: Install ground enhanced ground rods as shown on the Drawings.
1. Hole[s] for each rod shall be augured, 12-in diameter and of the appropriate depth per the manufacturer published instructions.
 2. Each section of the rod shall be connected with a manufacturer's standard coupling fitting.
 3. The inside of each rod shall be filled with the manufacturer's enhancement salts.
 4. Fill the hole around the rod with backfill material recommended by the manufacturer. Backfill material shall meet the requirements of ANSI/NSF Standard 60

3.03 INSPECTION AND TESTING

- A. Inspect the grounding and bonding system conductors and connections for tightness, proper installation, and proper application of electrical joint inhibitor compound.
- B. Testing shall be performed before energizing the distribution system. Refer to Section 26 08 00.
- C. A separate grounding system test shall be conducted for each building or system.
- D. Notify the Engineer immediately if the resistance to ground for any building or system is greater than five ohms or if the resistance to ground for a substation is greater than one ohm.

END OF SECTION

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SECTION 26 05 33

RACEWAY AND BOXES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work included:

1. This section covers the work necessary to furnish and install, complete raceways and boxes for electrical systems.
2. Raceway Schedules indicating conductor number and minimum required conductor sizes are included in Appendix 26 05 33-A. The Schedules are prepared as a guide to the Contractor and additional circuits from home runs, specialty manufacturers cables, and supplier specific wiring may require additional conductors not specifically included in the schedule. Such items not included in the Schedules shall not relieve the Contractor of the responsibility of furnishing and installing the necessary cables and raceways as required by the remainder of the Contract Documents for a fully functioning and operational system.
3. Home runs indicated are to assist the Contractor in identifying raceways to be installed concealed or exposed. Raceways identified to be installed exposed on the Drawings shall be run near the ceilings or along the walls of the areas through which they pass and shall be routed to avoid conflicts with HVAC ducts, cranes and hoists, lighting fixtures, doors and hatches. Raceways indicated to be run concealed shall be run in the center of concrete floor slabs, in partitions, or above hung ceilings, as required.
4. Raceway supports and restraints indicated on the Drawings are shown only to convey the general intent of the design and not intended to represent a complete system for all locations. The absence of location and specific details of the supports, additional restraints, and other mounting details on the Drawings shall not relieve the Contractor of the responsibility for providing them as specified. Raceway support layouts, supporting calculations, and required hardware for the raceway system are included in the Contractor's Scope of Work.

1.2 RELATED SECTIONS:

1. Conduit Schedules are included under Appendix 26 05 33-A
2. Section 01 61 20 - Seismic Design Criteria
3. Section 26 05 00 – Common Work Results for Electrical
4. Section 26 05 43 - Underground Ducts and Raceways for Electrical Systems

1.3 SUBMITTALS

- A. Submit data in accordance with Section 01 33 00 and Section 26 05 00.
- B. Submit manufacturers' names, product designation, and catalog numbers with marked cut sheets clearly and uniquely identifying all materials to be provided under this Section. Submit data for conduits, raceways, fittings, boxes, hardware, identification systems, and other materials specified in this Section.
- C. Submit specific details and methodology for water sealing around conduits entering structures below grade. Submittal shall include plan showing locations of entries, method

of entry (core drill, block out, etc.), method for sealing against entry of water into the building or structure, and sealing materials or devices.

- D. Submit sealing schedule for conduit sealing procedures for hazardous locations as specified herein.
- E. Submit complete layout and details of raceway supports, bracing, and connections, for all support systems. Submit raceway support calculations stamped and signed by a licensed Professional Engineer (Civil or Structural) in California for mounting hardware and all raceway support systems for review. Submit support system calculations and details as follows:
 - 1. Seismic criteria for calculations anchoring requirements are included in Section 01 61 20.
 - 2. Support systems calculations shall conform to the support design requirements as specified. Support calculations shall include weight of the raceway, fittings, and conductors for the specific or representative raceway element.
 - 3. Calculations shall include method and locations of supports and anchoring, including means for attaching to existing or new structure, mounting hardware details, and all assumptions used for the calculations.

1.4 SUPPORT DESIGN REQUIREMENTS

A. General

- 1. Seismic design requirements shall be in accordance with Section 01 61 20.
- 2. Seismic restraints shall be designed and provided to resist raceway system movements and loads occurring as a result of a seismic event. Unless otherwise specified, all raceway systems weighting 5 pounds/foot shall have bracing to resist seismic loading caused by forces as required by Section 01 61 20.
- 3. All items shall be designed with liberal strength and stiffness to support, restrain, and allow expansion of the respective tray under the maximum combination of peak loading conditions to include raceway weight, circuit weight, thermal expansion and contraction, vibrations, fittings and all probable externally applied forces.

B. Anchor Bolts/Systems

- 1. Calculate, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear, and pullout loads imposed by loading and spacing on each particular support. Anchoring system shall comply with the requirements of Section 01 61 20 and Section 05 50 00.

C. Supports

- 1. Vertical and horizontal supporting members shall be U-shaped channels similar to Unistrut, Series P1000. Vertical runs shall be secured to the horizontal members by pipe clamps or pipe straps. All components shall be of materials as specified noted.
- 2. Support not otherwise specified herein shall be fabricated or constructed from standard structural steel shapes in accordance with applicable provisions of Section 05 50 00, or Strut-type frame; have anchor hardware similar to items previously specified herein; shall meet the minimum requirements listed below; and be subject to the approval of the Engineer.

1.5 REFERENCES

- A. American National Standards Institute (ANSI)
 - 1. ANSI C80.1: Electrical Rigid Steel Conduit (ERSC).
 - 2. ANSI C80.3: Steel Electrical Metallic Tubing
 - 3. ANSI C80.4: Fittings for Rigid Metal Conduit and Electrical Metal Tubing.
- B. California Code of Regulations
 - 1. Title 24, Part 3 – California Electrical Code (NEC)
- C. National Electrical Manufacturer's Associate (NEMA)
 - 1. NEMA FB 1: Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
 - 2. NEMA RN 1: Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
 - 3. NEMA TC2: Electrical Polyvinyl Chloride (PVC) Conduit
 - 4. NEMA TC3: Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing
- D. Federal Specifications (FS)
 - 1. FS W-C-586D (A-A-50563): Conduit Outlet Boxes, Bodies, and Entrance Caps, Electrical: Cast Metal
 - 2. FS W-C-1094: Conduit and Conduit Fittings Plastic, Rigid
- E. Underwriters Laboratory (UL)
 - 1. UL 6: Electrical Rigid Metal Conduit - Steel
 - 2. UL 514B: Fittings for Conduit and Outlet Bodies
 - 3. UL 651A: Type EB and A Rigid PVC Conduit and HDPE Conduit
 - 4. UL 797: Electrical Metallic Tubing – Steel
 - 5. UL 1203: Hazardous Location Fittings
 - 6. UL 1242: Electrical Intermediate Metal Conduit – Steel
 - 7. UL 1660: Liquid-Tight Flexible Non-Metallic Conduit

1.6 CONDUIT SCHEDULES

- A. General: Conduit schedules are included in Appendix 26 05 33-A.
- B. Identification: Conduits are identified on the Drawings using a tagging scheme as follows:
XX#####A
where
XX: one or two letter designating function per the table below
#####: conduit number [including area number and equipment number] [including equipment number] [MCC source/equipment number] as required.

A: for parallel power feeder conduits, merged control conduits, parallel fiber optic conduits, or otherwise as required to ensure uniqueness

C. Functional Designation Table

Conduit Designator Table

Letter Designator	Function
B	DC Battery
C	Control and Monitoring 120V
CM	Control and Monitoring 120V, Multiconductor Cable
EL	UPS 120V Circuit - UPS Sourced
EP	UPS 480V Circuit - UPS Sourced
FA	Fire Alarm
FO	Fiber Optic
J	Control, Low Voltage DC Discrete
L	240/208/120V Panelboard Circuit
M	Power, Medium Voltage
N	Other Network or Data Link
P	Power, <=480V
S	Low Voltage Signal (4-20mA)
T	Telephone/Communications
U	Utility Service Conduits
X	Spare (e.g., PX#### = spare power conduit)

1.7 QUALITY ASSURANCE

- A. The Contractor shall require that all persons engaged in the installation of PVC coated rigid steel conduit, elbows, nipples, and fittings attend installation training classes given by the approved manufacturer at the job site before any conduit installation work begins and be able to provide a valid, un-expired certification card. The Engineer shall take part in the installation training classes. The classes shall be carried out by technically competent and experienced instructors who are certified manufacturer's employees and instructors acceptable to the Engineer. The Contractor shall notify the Engineer two weeks in advance of the scheduled classes.
- B. The Contractor shall demonstrate to the Engineer that the approved manufacturer's recommended installation tools and methods are being utilized on the job site by all persons engaged in the installation of PVC coated rigid steel conduit, elbows, nipples, and fittings. These tools and methods shall include, but not be limited to, clamp inserts for use on power driven units of chain vises, new die heads and enlarged pipe guides in conduit threading machines, and strap wrenches and extra wide wrench jaws for use in conduit assembly.
- C. A PVC Coated Sealing Locknut shall be used on all exposed male threads transitioning into female NPT threads which do not have sealing sleeves, including transitions from PVC couplings/female adapters to PVC coated GRC elbows in direct burial applications. PVC Coated Sealing Locknuts are not to be used in place of a conduit hub.

PART 2 - PRODUCTS

2.1 STEEL CONDUIT AND FITTINGS

- A. Galvanized Rigid Steel Conduit (GRS)

- B. Hot-dipped galvanized rigid steel conduit, including threaded type couplings, elbows, nipples, and other fittings, shall meet the requirements of ANSI C80.1, ANSI C80.4, UL and the NEC. Do not use setscrew or threadless type couplings, bushings, elbows, nipples, and other fittings, except when approved in writing by the Engineer.
- C. Provide medium wall intermediate metal conduit (IMC), couplings, factory elbows, and fittings; steel tubing with a hot-dipped galvanized finish inside and out after fabrication and threading. IMC shall conform to UL1242.
- D. Provide thin wall electrical metallic tubing (EMT), factory elbows, couplings, and fittings; steel tubing with an electrically galvanized finish after fabrication. EMT shall conform to ANSI C80.3 and UL797.
- E. Acceptable Manufacturers:
 - 1. Allied Tube and Conduit
 - 2. Western Tube & Conduit Corporation
 - 3. Cal Pipe Industries, Inc
 - 4. Approved equal

2.2 RIGID POLYVINYL CHLORIDE CONDUIT (PVC) AND FITTINGS

- A. PVC conduit shall be Schedule 40 [or 80], UL listed for concrete encased, underground direct burial, concealed, and direct-sunlight, weather-exposed use. Provide PVC conduit manufactured from virgin PVC compounds conforming to UL 651, listed and marked for use with 90° C insulated conductors.
- B. PVC conduits, couplings, elbows, nipples, and other fittings shall meet the requirements of NEMA TC 2 AND TC 3, Federal Specification W-C-1094, NEC Article 352, and ASTM D-1784 specified tests for the intended use.
- C. Provide conduits having a factory formed bell on one end. Conduit that requires the use of couplings for straight runs will not be acceptable.
- D. Acceptable Manufacturers:
 - 1. Carlon/Thomas and Betts (Lamson & Sessions) Plus 40 Rigid PVC Nonmetallic Conduit
 - 2. PW Eagle (PW Pipe)
 - 3. Allied Tube and Conduit (Tyco)
 - 4. Approved equal

2.3 PVC COATED RGS CONDUIT AND FITTINGS

- A. PVC-coated rigid steel conduit shall be hot-dipped galvanized rigid steel conduit meeting the requirements of NEMA RN 1, UL/6, and ANSI C80.1. Provide a factory installed PVC coating, 40 mils nominal thickness, and applied over and permanently bonded to the galvanized surface. Coating shall include an interior 2 mil urethane coating.
- B. All male threads on conduit, elbows, nipples and other fittings shall be protected by an application of a urethane coating; they shall be threaded and galvanized with integral plastic sleeves overlapping the plastic-coated conduit.
- C. Provide PVC coated conduit suitable for conductors with 75°C insulation.
- D. Product shall bear the ETL PVC-001 certification mark.
- E. Acceptable Manufacturers:
 - 1. Robroy, Plasti-Bond Red

2. Perma-Cote Industries, Supreme Conduit System
3. Approved equal

2.4 FLEXIBLE METAL CONDUIT, LIQUID-TIGHT

- A. Flexible metal conduit shall be UL listed per UL 360, liquid-tight, consisting of galvanized steel flexible conduit core covered with an extruded PVC jacket and terminated with nylon bushings or bushings with steel or malleable iron body and insulated throat and sealing O-ring.
- B. Provide conduit with sunlight resistant outer jacket, suitable for both concealed and exposed location. Conduit shall be suitable for use in classified locations as defined by the NEC.
- C. Acceptable Manufacturers:
 1. Allied Tube & Conduit (Tyco), Liquid-Tuff
 2. Anamet, Anaconda Sealtite Type UA
 3. Electri-Flex Liguatite Type LA
 4. Approved equal

2.5 FLEXIBLE NON-METALLIC CONDUIT, LIQUID-TIGHT

- A. Non-metallic flexible conduit shall be seamless, liquid-tight UL 1660 listed, Type B conduit with rigid non-metallic reinforcing embedded in integral flexible PVC lining and jacket wall and shall be oil, acid, ozone and alkaline resistant, rated 105 degree C, 60 degree C wet, 70 degree C oil resistant.
- B. Non metallic conduit fittings shall be dusttight, liquid-tight, sunlight and chemical resistant, thermoplastic/nylon construction with tapered thread hub and integral neoprene O-ring gasket.
- C. Acceptable manufacturers:
 1. CARLON "CARFLEX"
 2. Allied Tube & Conduit (Tyco), Liquid-Tuff
 3. Hubbel/Kellems "PolyTuff I"
 4. Approved equal

2.6 MISCELLANEOUS RACEWAY FITTINGS

- A. Rigid Steel Fittings
 1. Watertight hubs for rigid steel conduit shall be male thread type zinc-plated malleable iron with recessed "O" ring seal.
 2. Acceptable Manufacturers:
 - a. OZ Gedney Type CHM
 - b. Appleton HUB Series
 - c. Myers Scru-Tite Hubs
 - d. Approved equal
 3. Provide insulated throat grounding bushings at each end of every metal conduit. Provide threaded zinc-plated malleable iron grounding bushings with solderless bonding screw and insulated throat rated for 150°C.

4. Acceptable Manufacturers:
 - a. Thomas & Betts Grounding and Bonding Bushings
 - b. OZ Gedney Type BLG
 - c. Appleton Threaded Grounding Bushings
 - d. Approved equal
 5. Provide all malleable iron conduit bodies and covers with captive stainless steel screws and neoprene gaskets.
 6. Acceptable Manufacturers:
 - a. Appleton Form 35 threaded Unilets
 - b. Kilark
 - c. Approved equal
 7. Conduit End Caps: Provide PVC end caps to plug spare conduits and protect against entry of rodents, water, or dirt into the spare conduit. Provide end caps designed to fit into the end of standard conduit trade sizes and include integral cap eyelet for tying off spare conduit pull ropes or string.
- B. PVC-Coated Rigid Steel Conduit Fittings:
1. General: All boxes and fittings used with PVC coated conduit shall be furnished with a PVC coating bonded to the metal, the same thickness as used on the coated steel conduit. The ends of couplings and fittings shall have a minimum of one pipe diameter PVC overlap to cover threads and provide a seal.
 2. Products shall bear the ETL PVC-001 certification mark where applicable.
 3. Provide insulated throat grounding bushings with threaded zinc-plated malleable iron grounding bushings with bonding screw and insulated throat rated for 150 degrees C.
 4. Acceptable Products:
 - a. Thomas & Betts Grounding and Bonding Bushings
 - b. OZ Gedney Type BLG
 - c. Appleton Threaded Grounding Bushings
 - d. Approved equal
 5. Provide watertight and corrosion resistant hubs with a minimum 40 mil PVC exterior coating, a urethane interior coating, and pressure sealing sleeves.
 6. Acceptable Manufacturers:
 - a. Robroy Plasti-Bond Red Type ST Hub
 - b. Perma-Cote Industries Supreme Type ST Hub
 - c. Approved equal
 7. Provide corrosion resistant conduit bodies sized as required by the NEC. Provide cast iron conduit bodies and covers with captive stainless steel screws, a 40 mil minimum PVC exterior coating, 2 mil (nominal) internal urethane coating, and pressure sealing sleeves on all conduit openings. Fittings shall be Form 8 with a V-Seal tongue-in-groove gasket and supplied with plastic encapsulated stainless steel cover screws. Form 8 fittings shall be UL Type 4X listed and IEC IP69 certified. Fittings shall be from the same manufacturer as the conduit in order to maintain system continuity and warranty. PVC Coated fittings for hazardous

locations shall be UL 1203 listed after the coating is applied and have a red metal tag attached to the fitting to signify compliance.

8. Acceptable Manufacturers:
 - a. Robroy Plasti-Bond Red Conduit Bodies
 - b. Perma-Cote Industries Supreme Conduit Bodies
 - c. Approved equal
- C. Liquid-Tight Flexible Metal Conduit Fittings:
 1. Throat Connectors:
 - a. In NEMA 4X areas, provide zinc-plated malleable iron or galvanized steel insulated throat connectors suitable for use in wet locations, with a minimum 40 mil PVC exterior coating and pressure sealing sleeves.
 2. Acceptable Manufacturers:
 - a. Robroy Plasti-Bond Red Liquid Tight Connectors
 - b. Perma-Cote Industries Supreme Liquidtight Connectors
 - c. Approved equal
 3. Hubs:
 - a. In NEMA 4X areas, provide watertight and corrosion resistant hubs with a minimum 40 mil PVC exterior coating, a urethane interior coating, and pressure sealing sleeves.
 4. Acceptable Manufacturers:
 - a. Robroy Plasti-Bond Red Type ST Hub
 - b. Perma-Cote Industries Supreme Type ST Hub
 - c. Occidental Coating Company OCAL-Blue Double-Coat Type ST Hub
 - d. Approved equal
 5. Conduit Bodies:
 - a. General: Provide conduit bodies sized as required by the NEC. Provide integral rollers and bushings to facilitate pulling and protect wire insulation for conduit bodies greater than 1-inch; provide mogul type conduit bodies for sizes greater than 2-inch.
 6. For areas not designated NEMA 4X, provide cast iron conduit bodies and covers with captive stainless steel screws and neoprene gaskets.
 7. Acceptable manufacturers:
 - a. Appleton Form 35 threaded Unilets
 - b. Crouse-Hinds Form 7 threaded condulets
 - c. OZ Gedney Form 7 threaded conduit bodies
 - d. Approved equal
 - e. For NEMA 4X areas, provide corrosion resistant conduit bodies sized as required by the NEC. Provide cast iron conduit bodies and covers with captive stainless steel screws, a 40 mil minimum PVC exterior coating and nominal 2 mil internal coating, and pressure sealing sleeves on all conduit openings. Fittings shall be Form 8 with a V-Seal tongue-in-groove gasket and supplied with plastic encapsulated stainless steel cover screws. Form

8 fittings shall be UL Type 4X listed and IEC IP69 certified. Fittings shall be from the same manufacturer as the conduit in order to maintain system continuity and warranty. PVC Coated fittings for hazardous locations must be UL 1203 listed after the coating is applied and have a red metal tag attached to the fitting to signify compliance.

8. Acceptable manufacturers:
 - a. Robroy Plasti-Bond Red Conduit Bodies
 - b. Perma-Cote Industries Supreme Conduit Bodies
 - c. Approved equal
9. Flexible couplings shall be type ECGJH as manufactured by the Crouse-Hinds Co.; Appleton Electric Co.; Killark Electric Manufacturing Co. or equal.
10. Explosion proof fittings shall be as manufactured by the Crouse-Hinds Co.; Appleton Electric Co.; O.Z./Gedney Co. or equal.

2.7 BOXES

A. NEMA 1 and NEMA 12 Utility Boxes:

1. Provide pressed steel switch and outlet device boxes hot-dipped galvanized after fabrication. Provide extra-depth boxes with knockouts, size and style suitable for the application.
2. Small boxes used for junction boxes or pull boxes 100 cubic inches and smaller shall be constructed of minimum 14 USS gage sheet steel, galvanized after fabrication. Provide boxes with minimum depth of 2-1/8-inches with overall size, style, and knockouts to match the application. Provide blank covers affixed with round head brass or stainless steel machine screws.
3. Boxes used for junction or pull boxes larger than 100 cubic inches shall be constructed of minimum 14 USS gage sheet steel, galvanized after fabrication. Provide boxes without knockouts with overall size and style to match the application. Provide blank covers affixed with round head brass or stainless steel machine screws. All joints shall be welded and edges ground smooth.
4. Acceptable Manufacturers:
 - a. Raco Manufacturing Co.
 - b. O.Z. Manufacturing Co.
 - c. Approved equal

B. NEMA 1 and NEMA 12 Terminal Boxes

1. Provide terminal boxes fabricated of sheet steel unless otherwise shown on the Drawings. Boxes shall have continuous welded seams and mounting feet. Welds shall be ground smooth. Boxes shall be flanged and shall not have holes or knockouts. Box bodies shall not be less than 14 gauge metal and covers shall not be less than 14 gauge metal. Covers shall be continuously hinged, gasketed with rolled lip, and fastened with stainless steel latches or clamps. Boxes shall be furnished with terminal mounting straps and brackets.
2. Acceptable Manufacturers:
 - a. Hoffman Engineering Co.
 - b. Lee Products Co.
 - c. Keystone/Rees, Inc.

- d. Approved equal
- C. NEMA 4 Utility Boxes
 - 1. Provide Type FD switch and outlet device boxes of cast or malleable iron or cast copper-free aluminum as required by the application. All device boxes shall be extra depth and gasketed. Covers shall be with cadmium-zinc finish with cast iron or aluminum covers and stainless steel screws.
 - 2. Boxes shall be UL514 listed 514 conforming to NEMA FB-1 and Federal Specification W-C-586D standards.
 - 3. Acceptable Manufacturers:
 - a. Hubbell-Killark
 - b. Appleton
 - c. Crouse-Hinds Co.
 - d. Approved equal
- D. Provide NEMA 4 or NEMA 4X terminal boxes, junction boxes, pull boxes etc., manufactured of Type 316 stainless steel unless otherwise noted. Boxes shall have continuous welded seams and mounting feet. Welds shall be ground smooth. Boxes shall be flanged and shall not have holes or knockouts. Box bodies shall not be less than 14 gauge metal and covers shall not be less than 12 gauge metal. Covers shall be continuously hinged, gasketed, and fastened with stainless steel clamps. Terminal boxes shall be furnished with terminal mounting straps and brackets.
 - 1. Acceptable Manufacturers:
 - a. Hoffman Engineering Co.
 - b. Lee Products Co.
 - c. Keystone/Rees, Inc.
 - d. Approved equal
- E. Provide NEMA 4X terminal boxes, junction boxes, pull boxes, etc. manufactured of fiberglass reinforced plastic with stainless steel hardware unless otherwise noted. Covers shall be continuously hinged and gasketed. Terminal boxes shall be furnished with terminal mounting straps and brackets.
 - 1. Acceptable Manufacturers:
 - a. Hoffman Engineering Co.
 - b. Lee Products Co.
 - c. Keystone/Rees, Inc.
 - d. Approved equal
- F. Hazardous (Classified) Location Boxes
 - 1. Explosion-proof boxes shall be designed for Class 1, Group D, Division 1 hazardous locations. They shall be cast iron with cadmium-zinc or hot-dipped galvanized finish, stainless steel or hot-dipped galvanized bolts; Type EJB as manufactured by the Crouse-Hinds Company; Appleton Electric Co.; The Pyle-National Co. or equal.]
 - 2. Explosion-proof boxes shall be designed for Class 1, Group D, Division 1 hazardous locations, and shall also have O-ring seals to meet NEMA 4 requirements. Boxes shall be aluminum, with stainless steel hinged covers and

stainless steel bolts; Type EJB-N4 as manufactured by the Crouse-Hinds Co.; Appleton Electric Co.; Adalet-PLM or equal.]

2.8 WIREWAYS

- A. For areas designated NEMA 1, or NEMA 12 on the Drawings, provide UL listed, hinged cover, NEMA 12 wireway bodies and covers fabricated from 16 gauge steel minimum, with an enamel or epoxy finish.
 - 1. Acceptable Manufacturers:
 - a. Square D Square-Duct Wireway
 - b. Hoffman
 - c. Approved equal
- B. For all other areas or where NEMA 3R, NEMA 4, or NEMA 4X is shown on the Drawings, provide UL listed, raintight, hinged cover NEMA 4X wireway bodies and covers fabricated from stainless steel.
 - 1. Acceptable Manufacturers:
 - a. Square D
 - b. Hoffman
 - c. Approved equal

2.9 RACEWAY SUPPORTS AND FITTINGS

- A. General: Raceways shall be supported using trapeze hangers, flush mounted hardware, conduit racks, and conduit hangers as shown on the Drawings and as required.
- B. For areas not designated as NEMA 4X on the Drawings, supports and fittings for support systems for electrical equipment and raceways shall be channel supports sized to meet specified seismic requirements. Finish shall be hot-dipped galvanized after fabrication for strut, pipe straps, clamp back spacers, hanger rod, strut nuts, u-bolts, beam clamps, and all other supports and fittings.
 - 1. Acceptable Manufacturers:
 - a. Unistrut
 - b. B-Line
 - c. Power Strut
 - d. Approved equal
- C. For areas designated as NEMA 4X on the Drawings; supports and fittings for support systems for electrical equipment and raceways shall be channel supports sized to meet seismic requirements. Materials of construction shall be 40 mil PVC coated hot-dipped galvanized steel, 316 stainless steel, or self-extinguishing fiberglass which meets UL94V-0 flammability tests, for strut, pipe straps, clamp back spacers, hanger rod, strut nuts, U-bolts, beam clamps, and other supports and fittings. However, selection of support material used shall be resistant to the material(s) stored or resident in the location where installed.
 - 1. Acceptable Manufacturers:
 - a. Robroy Plasti-Bond-Red PVC Coated Steel Strut and accessories
 - b. Perma-Cote Supreme PVC Coated Steel Channel and accessories
 - c. Approved equal

2.10 EXPANSION AND DEFLECTION COUPLINGS

- A. General: Provide expansion and/or deflection couplings for use where shown and wherever conduit crosses an expansion joint. The couplings shall alleviate longitudinal, angular, and shear conduit stress caused by thermal expansion and/or differential settlement.
- B. Couplings shall be suitable for either rigid metallic or non-metallic conduits and for embedded or exposed applications.
- C. Requirements:
 - 1. Suitable for concrete-embedded or exposed wet locations. Weatherproof, watertight, corrosion-resistant construction.
 - 2. Axial expansion or contracting up to 3/4 inch
 - 3. Angular misalignment of the axes of the coupled conduit runs in any direction up to 30 degrees
 - 4. Parallel misalignment of the axes of coupled conduit runs in any direction up to 3/4 inch
 - 5. Integral flexible copper braid grounding straps to assure grounding continuity
 - 6. Stainless steel jacket clamps
 - 7. Integral Erickson union
 - 8. Couplings shall comply with UL standard 514B.
 - 9. Acceptable Manufacturers:
 - a. Crouse-Hinds Type XD
 - b. Appleton, Type DF
 - c. O.Z. Gedney Co. Type AXDX
 - d. Thomas and Betts, Type XD
 - e. Approved equal

2.11 CONDUIT TAGS

- A. Provide permanent, stamped brass round tags conduit numbers as designated on the conduit schedule, pressure stamped onto the tag. Stamped conduit identification numbers shall have a minimum height of ¼-inches. Tags shall be fabricated from minimum 19 gauge brass with minimum diameter of 1-1/2-inches and predrilled mounting top hole.
- B. Tags relying on adhesives or taped-on markers are not acceptable. Attach tags to conduits with 316 stainless steel clamps at each end and at least once in every 50 feet near the midpoint of exposed conduit in ceiling spaces, surface mounted, and inside manholes and handholes.
- C. Conduits installed higher than 15 feet above finished grade or finished floor elevations shall be provided with large plastic identification nameplates at these locations. Minimum character size shall be 1/2" black engraved lettering on white plastic nameplate.
- D. Acceptable products
 - 1. Seton Identification Products
 - 2. National Band and Tag Company
 - 3. Emedco
 - 4. Approved equal.

2.12 CONDUIT WALL AND SLAB PENETRATION SEALS AND SLEEVES

A. General

1. Conduit penetrations into buildings or structures shall be sealed to prevent infiltration of water into or out of the structure.
2. Provide modular, mechanical type conduit penetration seals consisting of fanged rubber type or interlocking synthetic rubber (EPDM) links shaped to continuously fill the annular space between the conduit and the opening or cast sleeve. The elastomeric element shall be sized and selected per the manufacturer's recommendations for the application shown on the Drawings. At a minimum, the seals shall be suitable for use in standard service applications (-40° F to 250° F) unless noted otherwise.
3. Sleeves shall be thermoplastic with water stops, suitable for poured wall construction.
4. Conduit penetration seals and sleeves shall be complete assemblies supplied by a single manufacturer.
5. Provide suitable seal for either conduit sleeve application or direct in core drilled wall or slab penetration as required or as shown on the Contract Documents.
6. Acceptable products: O-Z Gedney Type CSM; Thunderline Corporation Link-Seal and Plastic Sleeves; Calpico Inc. Pipe Linx and Plastic Sleeves; or approved equal.

2.13 DUCT SEAL

A. General Penetration Sealant

1. Provide non-hardening compound designed as a waterstop and moisture barrier for sealing the conduit annular space between conduit and electrical conductors. Material shall also be suitable for use around conduit entrance points including service conduits wood, metal, or other materials where shown on the Drawings. Seal material shall be asbestos free, non-toxic, and non-corrosive to metals and plastic, including wire insulation. Material shall be reusable, paintable. And suitable for locations with thermal expansion and contraction.
2. Acceptable Products:
 - a. O-Z Gedney DUX
 - b. Rainbow Technology, Duct Seal Putty
 - c. Approved equal

B. Fire Rated Penetration Sealant

1. Provide conduit penetration and cable sealant similar to general penetration sealant except provide material with fire rating that meets or exceeds the wall or floor construction as shown on the Drawing. Material shall be solvent free and UL or FM approved for the application.
2. Acceptable Products:
 - a. Thomas & Betts Corp.; Pro Set Systems
 - b. Neer Mfg. Co.
 - c. Spec Seal, LCI Sealant
 - d. McMaster-Carr, 9340
 - e. Approved equal with fire rating as required for the application.

PART 3 - EXECUTION

3.1 GENERAL

- A. Check the approximate locations of raceway system components shown on drawings for conflicts with openings, structural members, and components of other systems and equipment having fixed locations. In the event of conflicts, consult the Engineer. Make modifications and changes required.
- B. Protection during construction: Prior to installation, store all products in a dry location. Following installation, protect products from the effects of moisture, corrosion, and physical damage during construction. Keep openings in conduit and tubing capped with manufactured seals during construction. Cover PVC conduit, elbows, and PVC coated rigid steel conduit, nipples, elbows, and fittings from exposure to sunlight.
- C. Material and equipment installation: Follow manufacturer's installation instructions explicitly, unless otherwise indicated. Wherever any conflict arises between manufacturer's installation instructions, codes and regulations, and these contract documents, follow Engineer's decision. Keep copy of manufacturer's installation instructions on the jobsite available for review at all times.
- D. No wire shall be pulled until the conduit system is complete in all details; in the case of concealed work, until all rough plastering or masonry has been completed; in the case of exposed work, until the conduit system has been completed in every detail.

3.2 INSTALLATION

- A. Minimum size conduit shall be 3/4-inch.
- B. Raceway type for location and installation method unless otherwise noted:
 - 1. Exterior, exposed, higher than 6-inches above grade:
 - a. Galvanized rigid steel conduit
 - 2. Interior, exposed unless noted otherwise:
 - a. Galvanized rigid steel conduit
 - 3. Interior, concealed, not embedded in concrete:
 - a. Rigid steel conduit
 - 4. Clean, dry, finished areas (offices, control rooms, etc.) and above suspended ceilings for conduits 1-inch and smaller for lighting and receptacle installation:
 - a. Electrical metallic tubing
 - 5. Embedded within or below structure concrete slabs or floors; installed within concrete or CMU walls:
 - a. PVC Schedule 40
 - 6. Risers through concrete pads:
 - a. PVC Coated rigid steel conduit.
 - 7. NEMA 4X areas:
 - a. PVC Coated rigid steel conduit.
 - 8. Exterior direct buried or concrete encased ductbanks (refer also to Section 26 05 43)
 - a. PVC Schedule 40

9. PVC coated rigid galvanized steel elbows shall be used for pad-mounted transformer stub-ups.
10. Conduits shall be installed using threaded fittings except for PVC or EMT. The use of running threads is prohibited. Where such threads are necessary, a 3-piece union shall be used. Rigid galvanized steel conduits which have been field cut and threaded shall be painted with cold galvanizing compounds.
11. Flexible metallic conduit (Type MC cable) shall be used for recessed fluorescent fixtures in hung ceilings to connect fixtures to the conduit system.
12. Rigid galvanized steel conduits buried in earth shall be completely painted with bitumastic.
13. PVC coated rigid galvanized steel conduit shall be used for elbows at risers at the utility pole for electrical and telephone service conduits. Rigid galvanized steel conduit shall be used at utility pole for electrical and telephone service and fire alarm conduits to a height of 10-ft above finished grade. Furnish and install weather heads at service pole riser if required by utility company.
14. Provide PVC coated rigid steel conduit under equipment mounting pads unless encased in concrete as specified herein.
15. In exterior light pole foundations; extend PVC schedule 40 conduit 6 inches above the top of the foundation or as shown on the Drawings.
16. Where conduit changes from underground direct burial to exposed; extend PVC coated rigid steel conduit up to 6 inches above finished grade or as shown on the Drawings.
17. Where exterior conduit transition through concrete walls, slabs, and floors to exposed runs, provide PVC coated rigid steel conduit with factory manufactured elbows. Extend PVC coated rigid steel conduit a minimum of 6-inches beyond the concrete walls, slabs, or floors or as shown on the Drawings.

C. PVC Coated Rigid Steel Conduit:

1. Suitable UL listed PVC coated conduits, boxes, and fittings only shall be used. Galvanized conduits with a subsequent or field application of PVC material is not acceptable.
2. Install in strict accordance with the manufacturer's instructions. Touch up any damage to the coating with conduit manufacturer acceptable patching compound. PVC boot shall cover all threads. Where belled conduits are used, bevel the unbelled end of the joint before joining. Leave no metallic threads uncovered. Clean field threads with solvent and coat with urethane touch-up. Keep two cans of urethane touch-up at each threading station.

D. Hazardous and Classified Locations

1. Conduits terminating at boxes enclosing circuit opening equipment shall be sealed at the entrance to the enclosure with approved compound filled sealing fittings to prevent passage of explosive or combustible gases through the conduits.
2. All conduits leading from or entering hazardous locations shall be similarly sealed at each point of entrance or exit.
3. Exposed conduits passing through hazardous locations shall be sealed at both the entrance to and the exit from the hazardous locations.
4. A sealing compound installation schedule shall be presented to the Engineer for approval. Each installation shall be signed off by the Contractor and the Engineer

and each fitting shall be legibly marked with red paint to indicate that the sealing compound has been installed.

5. Conduit sealing and drain fittings shall be installed in all hazardous (classified) areas designated Class 1, Division 1, and Class 1, Division 2.

E. Location, Routing, and Grouping:

1. Conceal or expose raceways as indicated on the Drawings. Group raceways in same area together. Locate raceways at least 12 inches away from parallel runs of heated piping for other utility systems.
2. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes to provide a neat appearance. Follow surface contours as much as possible. No diagonal runs will be allowed. All conduits shall be run plumb, straight, and true.
3. Run concealed raceways with the minimum of bends in the shortest practical distance considering the building construction and other systems.
4. In block walls, do not route raceways in the same horizontal course with reinforcing steel.
5. In outdoor, underground, or wet locations, use watertight couplings and connections in raceways. Install and equip boxes and fittings so as to prevent water from entering the raceway.
6. Do not notch or penetrate structural members for passage of raceways except with prior approval of the Engineer.
7. Do not run raceways horizontally in equipment foundation pads.
8. Separate raceway in slabs not less than three times the largest raceway outside diameter minimum, except at raceway crossings, and then only with the approval of the Engineer. Embed conduits in walls, floors, slabs, or overhead in the middle one-third of the concrete and at least 3-inches from the concrete surface; thicken slabs where necessary to accommodate conduits in a manner as approved by the Engineer.
9. Do not route raceways exposed across walkways unless approved conduit threshold coverings are provided.
10. Route conduits within the furring lines of building walls and ceilings unless specifically noted to be exposed.
11. Provide all necessary sleeves and chases required where conduits are routed through floors or walls; seal all openings and finish to match adjacent surfaces.
12. Where conduit routing changes from concrete embedded within floors, slabs, or equipment pads to exposed, maintain a minimum separation of 6-inches between the closest wall, pad, or structure face and the outer edge of the exposed conduit.
13. Where conduits are routed through openings in walls or floor slabs, the remaining openings shall be sealed against the passage of flame and smoke in accordance with UL requirements and the details shown on the Drawings. The sealing method shall have a UL fire rating, which equals or exceeds the fire rating of the wall or floor construction.
14. Conduits shall not be routed to cause obstruction of passageways to pedestrian or vehicular traffic. Conduits shall not be routed across pipe shafts, access hatches or vent duct openings. They shall be routed to avoid such present or future openings in floor or ceiling construction.

15. Conduits routed from heated to unheated spaces, exterior spaces, refrigerated spaces, cold air plenums, etc, shall be sealed with "Duxseal" as manufactured by Manville or seal fitting to prevent the accumulation of condensation.
16. Conduits shall be routed a minimum of 3-in from steam or hot water piping. Where crossings are unavoidable, the conduit shall be kept at least 1-in from the covering of the pipe crossed.
17. A mandrel shall be pulled through all existing conduits to be reused under this Contract and through all new conduits 2-in in diameter and larger. Conduits shall be proved with the mandrel prior to installation of any conductors.
18. Emergency (generator) source and normal (power company) source feeders shall not be run through the same pull box.

F. Box Applications

1. Unless otherwise specified herein or shown on the Drawings, all boxes shall be metal.
2. Pull boxes, junction boxes, or terminal boxes shall be used in any conduit run where a splice is required. Pull boxes shall be provided every 200 feet of straight run, every 150 feet with 90 degrees of bends, every 100 feet with 180 degrees of bends, and every 50 feet with 270 degrees of bends.
3. Where no type or size is indicated for junction boxes, pull boxes or terminal cabinets, they shall be sized in accordance with the requirements of the NEC. Enclosure type and material shall be as specified herein.
4. Exposed switch, receptacle and lighting outlet boxes and conduit fittings shall be cast or malleable iron, except that non-metallic PVC shall be used with PVC.
5. Concealed switch, receptacle and lighting outlet boxes shall be pressed steel.
6. Terminal boxes, junction boxes and pull boxes shall have NEMA ratings suitable for the location in which they are installed, as specified in Section 26 05 43.
7. Boxes flush in block, brick or tile walls shall be located at a course line and provided with square tile covers. Flush boxes shall not project beyond the finished surfaces nor shall surfaces project more than 1/8-in beyond the box enclosure. Wiring devices located in close proximity to each other shall be installed in one solid gang box with single cover.
8. All conduit bodies and pulling outlets shall comply with NEC wire bending space requirements. Mogul type fittings shall be used for sizes 2-1/2-in and larger. Where left or right side opening conduit bodies may be required for larger size conductors, provide pull boxes or other means where mogul style is not available. In no case shall the listed fill size cross sectional area for the conduit body be exceeded by the installed wire.
9. Conduit terminating in pressed steel boxes shall have double locknuts and insulated bushings
10. PVC conduit to non-metallic box connections shall be made with PVC socket to male thread terminal adapters with neoprene O-ring and PVC round edge bushings.
11. PVC boxes, conduit fittings, etc, with integral hubs shall be solvent welded directly to the PVC conduit system.
12. Non-metallic boxes with field drilled or punched holes shall be connected to the PVC conduit system with threaded and gasketed PVC Terminal Adapters.

- G. Final connection to equipment subject to movement or vibration:
1. Provide liquid-tight, PVC-jacketed flexible conduit for final connection to motors, wall or ceiling mounted fans and unit heaters, dry type transformers (primary and secondary terminations), generator terminations, valves, local instrumentation, and other equipment where flexible connection is required for vibration and to facilitate removal or adjustment of equipment.
 2. Provide 18-inch minimum, 60-inch maximum lengths unless otherwise approved by the Engineer. Provide flexible conduit size for installations of 4 inches or less. For larger sizes, use rigid steel conduit as specified.
 3. The flexible conduit length shall be sufficient to allow the connected equipment to be withdrawn and fully moved off its base.
 4. Non-metallic flexible conduit may be used for such connections when part of rigid PVC conduit systems.
 5. Flexible couplings shall be used in hazardous locations for all motor terminations and other equipment where vibration is present.
- H. Wireways: Mount wireways securely in accordance with the NEC and manufacturer's instructions. Orient cover on accessible vertical face of wireway to allow removal of all fasteners and complete removal or rotation of cover for installation of conductors.
- I. Raceway Supports
1. General:
 - a. Support raceways at intervals not exceeding NEC requirements unless otherwise indicated. Supports shall be provided to ensure a rigid and durable installation.
 - b. Support spacing and anchoring method shall be as required by the seismic mounting calculations. All support spacing requirements specified are maximum values only and shall be increased as necessary based on the final seismic calculations as specified. Anchoring method specified shall be modified as required by the final seismic calculations as specified.
 - c. Support all raceways from structural members only. Do not support from pipe hangers or rods, cable tray, or other conduit.
 - d. Support flexible metal conduit with conduit clamps, except where the flexible metal conduit is fished and where sections less than 4 feet in length are used in concealed areas to supply lighting fixtures in accordance with the NEC. Adjustable steel and plastic band hangers, adjustable band hangers, adjustable swivel ring hangers and J-hangers are not acceptable.
 - e. Attachment to concrete shall be cast-in-place inserts, cast-in place welded plates with welded studs or stainless steel adhesive anchors.
 - f. Do not use nails anywhere or wooden plugs inserted in concrete or masonry as a base for raceway or box fastenings. Do not weld raceways or pipe straps to steel structures. Do not use wire in lieu of straps or hangers.
 - g. All reinforcing bars shall be located by the Contractor with the use of a rebar locator prior to installing adhesive capsule type anchors. Mark the location of all reinforcing bars in an area bounded by a line drawn at least 18-in from the edge of the support bearing/weld plates on all four sides of the bearing/weld plates prior to fabricating and installing bearing/weld plates.

- h. Where interference occurs, adjust anchor locations to clear reinforcing bars and alter support configuration at no additional cost to the Authority.
 - i. Miscellaneous steel for the support of fixtures, boxes, transformers, starters, contactors, panels and conduit shall be furnished and installed. Channel supports shall be ground smooth and fitted with plastic end caps.
 - j. Steel channels, flat iron and channel iron shall be furnished and installed for the support of all electrical equipment and devices, where required, including all anchors, inserts, bolts, nuts, washers, etc, for a rigid installation. Channel supports shall be ground smooth and fitted with plastic end caps.
2. PVC conduit shall be supported with non-metallic clamps, [PVC coated steel] [non-metallic] racks and stainless steel hardware.
 3. Single conduits shall be supported by means of one-hole pipe clamps in combination with one-screw back plates, to raise conduits from the surface.
 4. Multiple runs of conduits shall be supported on fabricated channel trapeze type racks with steel horizontal members and threaded hanger rods. The rods shall be not less than 3/8-in diameter. Surface mounted panel boxes, junction boxes, conduit, etc, shall be supported by spacers to provide a minimum of 1/2-in clearance between wall and equipment.
 - a. Conduit support trapezes shall be vertically supported every 10-ft or less, as required to obtain rigid conduit construction.
 - b. Lateral restraints (sway bracing) shall be spaced 30-ft or less.
 - c. Horizontal restraints shall be spaced at 40-ft or less. There shall be at least one horizontal restraint per horizontal run.
 - d. Trapeze attachment to structural steel shall be by beam clamps or welded beam attachment. C-clamps will not be allowed for vertical hangers. Side beam clamps with beam hooks shall be used when required for seismic restraints only.
 5. Conduit Racks
 - a. Support shall be spaced 10-ft or less, as required to obtain rigid conduit construction.
 - b. Horizontal seismic restraints shall be spaced at 30-ft or less.
 6. Conduit Hangers
 - a. Conduit hangers shall be vertical supported 10-ft or less.
 - b. Lateral seismic restraints (Sway Bracing) shall be spaced 20-ft or less.
 - c. Horizontal seismic restraints shall be spaced at 30-ft or less. There shall be at least one horizontal restraint per horizontal run.
 - d. Attachment to structural steel shall be by beam clamps or welded beam attachment. C-clamps will not be allowed for vertical hangers. Side beam clamps with beam hooks shall be used for seismic restraint only.

J. Bends

1. Make changes in direction of runs with symmetrical bends or cast metal fittings. Make bends and offsets of the longest practical radius. Avoid field-made bends and offsets where possible, but where necessary, make with an acceptable hickey or conduit bending machine. Do not heat metal raceways to facilitate bending.

2. Make bends in parallel or banked runs of raceways from the same center or centerline so that bends are parallel, concentric, and of neat appearance. Factory elbows may be used in parallel or banked raceways if there is a change in the plane of the run and the raceways are of the same size. Otherwise, make field bends in parallel runs.
 3. For PVC Schedule 40 conduits, use factory made elbows for all bends 30 degrees or larger. Use acceptable heating methods for forming smaller bends.
 4. Make no bends in flexible conduit that exceed allowable bending radius of the cable to be installed or that significantly restricts the conduits flexibility.
- K. Threaded Joints
1. Paint all field-cut threads with zinc rich paint or liquid galvanizing compound for rigid steel conduit and for PVC-coated rigid steel conduit after removal of chips and cleaning with solvent. Touch up after assembly to cover nicks or scars.
 2. Use approved, highly conductive jointing compound on all joints, Appleton Type TLC, or approved equal.
- L. Bushings, Hubs, and Insulating Sleeves:
1. Where rigid steel conduit, PVC coated rigid steel conduit, or liquid-tight flexible metal conduit enters metal cabinets/enclosures, install an insulated throat grounding bushing on the end of each conduit. Install a bonding jumper from the bushing to suitable equipment ground bus or ground pad. Ground pads designated for instrumentation signal grounds as specified in Division 40 shall not be used for this purpose.
 2. Interconnection or daisy-chaining of bonding jumpers from each conduit grounding bushing to the equipment ground bus or ground pad is acceptable.
 3. If neither a ground bus or ground pad exists, connect the bonding jumper to the metallic enclosure with a listed bolted-lug connection.
 4. All connections between conduits and NEMA 1, 1A, and 12 enclosures shall be made with hubs outside and bushings on the inside.
 5. Conduit connections to NEMA 3R, NEMA 4, or NEMA 4X enclosures, junction boxes, terminal junction boxes, or device outlet boxes, shall be made with watertight, corrosion resistant hubs. The conduit connections shall maintain the integrity of the enclosure NEMA rating.
- M. Raceway Penetrations:
1. Seal the interior of all raceways entering structures or buildings at the first box or outlet with duct seal to prevent the entrance into or exit from the structure of gases, liquids, or rodents.
 2. All underground conduit penetrations at walls or other structures shall be sealed watertight using wall seals in core drilled openings or with specified conduit wall sleeves. Conduit wall seals and sleeves shall be used in accordance with the manufacturer's installation instructions and the details shown on the Drawings.
 3. Below Grade Penetrations or Penetrations Through Walls of Water Bearing Structures.
 - a. Where conduit enters a new structure below grade through a concrete slab or wall, or where conduit penetrates a new wall of a water bearing structure, install a watertight mechanical conduit penetration seal and sleeve. Cast the conduit sleeve directly into the concrete wall or floor slab as shown on the Drawings. Install the sealing assembly such that it may be tightened at any time from the interior or dry side.

- b. Where conduit enters an existing structure below grade through a concrete wall, slab, or where conduit penetrates a new wall of a water bearing structure, core drill through the existing wall and install a watertight conduit penetration seal. Install the sealing assembly such that it may be tightened at any time from the interior side.
 - c. For wall thicknesses less than 12-inches, dry pack around the conduit and the sealing assembly on the exterior side with non-shrink grout as shown on the Drawings. Provide double sealing for walls thicknesses 12-inches and greater.
 - d. For concrete surfaces having moisture membranes, provide dual seals with suitable membrane clamp as shown on the Drawings.
 - 4. Above Grade Penetrations
 - a. Seal all above grade penetrations of concrete, CMU, metal, or wooden walls or roofs with duct seal. Install duct seal around conduit penetrations and inside conduits for sealing the annular space between conduit and conductors.
 - b. Where raceways penetrate fire-rated walls, floors, or ceilings, provide fire stop material as specified herein or per Division 7 [Section 07 84 00] in openings around electrical penetrations to maintain the fire-resistance rating.
 - 5. Gas Containment Area Sealing: Internally and externally seal each conduit entering or leaving any area containing noxious gases to prevent contamination into clean areas via the conduit system. Areas requiring this protection are rooms where chlorine, ammonia and ozone are stored, generated or handled. Caulking material for conduit internal use shall be synthetic elastomer type, 3M, Series CP25 or equal. External sealing shall be in accordance with the typical details shown on the Drawings.
 - 6. Liquid Chemical Containment Area Sealing: Internally and externally seal each conduit entering or leaving any liquid chemical containment areas to prevent chemical migration or drainage via the conduit system. Sealing shall be in accordance with the typical details shown on the Drawings. Seal conduits with a polyurethane elastomeric caulking material installed in accordance with the manufacturer's instructions. The material shall be SikaFlex-2C used with the primer No. 449 or No. 260 as appropriate for the conduit or approved equal.
- N. Expansion Joints:
 - 1. Provide expansion/deflection fittings for raceways crossing expansion joints in structures, between structures and walkways or concrete slabs to compensate for expansion, contraction, and deflection. Provide for the high rate of thermal expansion and contraction of PVC conduit by providing PVC expansion joints as recommended by the manufacturer and as required. See Structural Drawings for locations of expansion joints.
 - 2. Provide expansion only fittings on exposed, rigid steel conduit runs a minimum of every 200 feet or as required for the specific thermal characteristics of the application.
 - 3. Provide bonding jumpers around expansion joint fittings.
- O. Rooftop Support System: Install support system securely in accordance with the NEC and manufacturer's instructions. Provide strut spacer between conduit and rubber base of material type suitable for the environment, as required by the application. Support system shall not be used for seismic anchoring.

3.3 PREPARATION FOR PULLING IN CONDUCTORS

- A. Do not install crushed or deformed raceways. Do install conductors in cruised or deformed raceways.
- B. Install raceways to avoid introduction of traps.
- C. Immediately after installation, plug or cap all raceway ends with watertight and dust-tight seals until the time for pulling in conductors. Take care to prevent the lodging of plaster, concrete, dirt, or trash in raceways, boxes, fittings, and equipment during the course of construction. Make raceways entirely free of obstructions or replace them.
- D. Ream all raceways, remove burrs, and clean raceway interior before introducing conductors or pull wires.
- E. For concrete-encased raceways (after the concrete envelope has set), and for direct buried conduits, pull a mandrel through each raceway to remove debris. Pull a mandrel of a diameter approximately 1/4 inch less than the raceway inside diameter, through each raceway. Use cleanout or flexible mandrels for conduit sizes greater than 2-inches; use rubber/foam mandrel for conduit sizes 2-inches and below.
- F. For all raceways which contain less than 50 percent of the NEC allowed fill of control cables or individual conductors, install a nylon pull rope with the conductors.

3.4 EMPTY RACEWAYS

- A. Certain raceways will have no conductors pulled in as part of this Contract. Identify with conduit tags at each end and at any intermediate pull point of each such empty, spare raceways.
- B. Raceways noted as spare shall be capped or plugged at both ends with easily removable conduit cap fittings
- C. Provide a fabricated, listed removable cap over each end of empty raceways. Provide cap with eyelet for tying off pull rope.
- D. 3/16-in nylon pull ropes shall be installed in all new or existing unused conduits noted as spares or designated for future equipment. Provide pull rope with a minimum of 3-feet of slack length at each end of each empty raceway. Tie off the pull rope at the conduit end cap eyelet.

3.5 IDENTIFICATION

- A. Attach conduit identification tags to conduits with 304 stainless steel hose clamps and/or stainless steel jack chains.
- B. Provide conduit identification tags for all conduits at each end of conduit and at least once in every 50 feet of exposed conduit runs.
- C. Provide conduit identification tags for each conduit inside all manholes and handholes.
- D. Conduits installed higher than 15 feet above finished grade or finished floor elevations shall be provided with large plastic identification nameplates at these locations. Attach plastic nameplates with plastic ties.

3.6 PAINTING

- A. Paint exposed metal raceway systems in accordance with the requirements of Section 09 90 00.

END OF SECTION

APPENDIX 26 05 33-A

CONDUIT SCHEDULES

The Schedules are prepared as a guide to the Contractor and additional circuits from home runs, specialty manufactured cables, and supplier specific wiring may require additional conductors not specifically included in the schedule. Such items not included in the Schedules shall not relieve the Contractor of the responsibility of furnishing and installing the necessary cables and raceways as required by the remainder of the Contract Documents for a fully functioning and operational system.

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SECTION 26 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work included:

1. Furnish and install a complete underground system of raceways, manholes, handholes, fittings, and hardware as shown on the Drawings and as specified herein.
2. Where referred to in this Section, raceways are underground conduits and fittings; ductbanks are a collection of underground raceways; the underground electrical system is the collection of underground ductbanks, manholes, handholes, hardware, and other below and at grade structures as specified.
3. Install ductbanks, manholes, and handholes locations and depths coordinated with other utilities, yard piping, yard structures and field conditions per the Contract Documents. Underground electrical systems shall be installed to avoid interferences with other utilities, structures, and site features.
4. All underground electrical raceway systems shall be encased in steel reinforced concrete ductbanks unless specifically indicated otherwise on the Drawings. Ductbanks shall be steel reinforced, concrete encased, and structurally tied to buildings, vaults, manholes, handholes or other structures where shown on the Drawings and where specified.
or
All underground electrical raceway systems shall be encased in concrete ductbanks unless specifically indicated otherwise on the Drawings. Ductbanks shall be concrete encased and structurally tied to buildings, vaults, manholes, handholes, or other structures where shown on the Drawings and where specified.
or
All underground electrical raceway systems shall be direct buried in earth with concrete cap unless specifically indicated otherwise on the Drawings. Transition from direct buried conduits at buildings, vaults, manholes, handholes or other structures shall be as shown on the Drawings and as specified.
or
All underground electrical raceway systems shall be direct buried in earth unless specifically indicated otherwise on the Drawings. Transition from direct buried conduits at buildings, vaults, manholes, handholes or other structures shall be as shown on the Drawings and as specified.
5. Related Work: Underground electrical systems for electrical power, telephone, or other utility shall be in conformance with the requirements of the serving utility as applicable and per the requirements of Section 26 05 00.

1.02 RELATED SECTIONS

- A. All trenching, drilling, backfill, compaction, and surface restoration shall be as indicated on the Drawings and as required under Division 31 of these Specifications. However, the responsibility of furnishing and installing the underground systems shall be included under this Section.
- B. All concrete and reinforcement shall be as indicated on the Drawings and as required in Division 3 of these Specifications. However, the responsibility of furnishing and installing the underground systems shall be included under this Section.
 - 1. Section 03 36 00 – Electrical and Instrumentation Duct Encasement Concrete
 - 2. Section 26 05 00 – Common Work Results for Electrical
 - 3. Section 26 05 26 – Grounding and Bonding for Electrical Systems
 - 4. Section 26 05 33 – Raceways and Boxes for Electrical Systems

1.03 SUBMITTALS

- A. Submittals shall be made in accordance with Section 01 33 00 and Section 26 05 00.
- B. Concrete mix design for ductbank concrete encasement shall be submitted per the requirements of Division 3.
- C. Submit the following:
 - 1. Raceway and conduit product catalog data indicating material, fittings, accessories, and sizes to be provided.
 - 2. Handhole, splice boxes, and manhole catalog data including details of the structures and lids including material of construction, design loadings, knockout locations, internal and external dimensions, sump locations, and accessories.
 - 3. Catalog data for underground raceway installation accessories including conduit spacers, cable racks, pull rope, pulling lubricants, sealants, identification warning tape, and other underground system components as specified herein.

1.04 REFERENCES

- A. American National Standards Institute
 - 1. ANSI C80.1: Electrical Rigid Steel Conduit (ERSC).
- B. American Society for Testing and Materials (ASTM)
 - 1. ASTM C857: Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
 - 2. ASTM D1784: Standard Specification for Rigid Poly (Vinyl-Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl-Chloride) (CPVC) Compounds
 - 3. ASTM F512: Standard Specification for Smooth-Wall Poly (Vinyl-Chloride) (PVC) Conduit and Fittings for Underground Installation
- C. California Code of Regulations.
 - 1. Title 24, Part 3 – California Electrical Code (NEC)

- D. Federal Specifications (FS)
 - 1. FS W-C-1094: Conduit and Conduit Fittings Plastic, Rigid
- E. National Electrical Manufacturer's Associate (NEMA)
 - 1. NEMA RN1: Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
 - 2. NEMA TC2: Electrical Polyvinyl Chloride (PVC) Conduit
 - 3. NEMA TC3: Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing
 - 4. NEMA TC6 and 8: Polyvinyl chloride (PVC) Plastic Utilities Duct for Underground Installations
- F. The American Association of State Highway and Transportation Officials (AASHTO)
 - 1. AASHTO T 180: Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop
- G. Public Utilities Commission State of California
 - 1. General Order No.128, Rules for Construction of Electric Supply and Communication Systems.
- H. United States Department of Agriculture: Rural Utilities Service (RUS)
- I. Underwriters Laboratories (UL)
 - 1. UL 6: Electrical Rigid Metal Conduit - Steel
 - 2. UL 514B: Fittings for Conduit and Outlet Bodies
 - 3. UL 651A: Type EB and A Rigid PVC Conduit and HDPE Conduit
- J. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A. Raceways, fittings, and other underground electrical system components shall be UL listed where such listings are available.
- B. The Contractor shall demonstrate to the Engineer that the approved manufacturer's recommended installation tools and methods are being utilized on the job site by all persons engaged in the installation of PVC coated rigid steel conduit, elbows, nipples, and fittings. These tools and methods shall include, but not be limited to, clamp inserts for use on power driven units of chain vises, new die heads and enlarged pipe guides in conduit threading machines, and strap wrenches and extra wide wrench jaws for use in conduit assembly. All tools and equipment used in the installation of PVC coated rigid steel raceways shall be in conformance with manufacturer's recommendations.

PART 2 - PRODUCTS

2.01 RACEWAYS AND FITTINGS

- A. Rigid Polyvinyl Chloride Conduit (PVC) and Fittings

1. PVC conduit shall be Schedule 40, UL listed for concrete encased, underground direct burial, concealed, and direct-sunlight, weather-exposed use. Provide PVC conduit manufactured from virgin PVC compounds conforming to UL 651, listed and marked for use with 90° C insulated conductors.
 2. PVC conduits, couplings, elbows, nipples, and other fittings shall meet the requirements of NEMA TC 2 AND TC 3, Federal Specification W-C-1094, NEC Article 352, and ASTM D-1784 specified tests for the intended use.
 3. Provide conduits having a factory formed bell on one end. Conduit that requires the use of couplings for straight runs will not be acceptable.
 4. Provide factory elbows and large radius sweep bends with standard radii for all underground installations. Elbows and bends shall be by the same manufacture as the straight conduit and match PVC requirements as specified herein.
 5. Acceptable Manufacturers:
 - a. Carlon/Thomas and Betts (Lamson & Sessions) Plus 40 Rigid PVC Nonmetallic Conduit
 - b. PW Eagle (PW Pipe)
 - c. Allied Tube and Conduit (Tyco)
 - d. Approved equal
- B. PVC Coated RGS Conduit:
1. PVC-coated rigid steel conduit shall be hot-dipped galvanized rigid steel conduit meeting the requirements of NEMA RN 1, UL/6, and ANSI C80.1. Provide a factory installed PVC coating, 40 mils nominal thickness, and applied over and permanently bonded to the galvanized surface. Coating shall include an interior 2 mil urethane coating.
 2. All male threads on conduit, elbows, nipples and other fittings shall be protected by an application of a urethane coating; they shall be threaded and galvanized with integral plastic sleeves overlapping the plastic-coated conduit.
 3. Provide PVC coated conduit suitable for conductors with 75°C insulation.
 4. Product shall bear the ETL PVC-001 certification mark.
 5. Acceptable Manufacturers:
 - a. Robroy, Plasti-Bond Red
 - b. Perma-Cote Industries, Supreme Conduit System
 - c. Approved equal
- C. PVC Type EB-20 Conduit: Provide PVC type EB-20, UL listed for concrete encased installation only and for conductors insulated for 90° C. Conduit, couplings, elbows, nipples, and other fittings shall meet the requirements of NEMA TC6 and 8, UL-651 and ASTM F512 specified tests. Conduit shall be RUS listed. Provide conduits with factory formed end bells at one end. Conduits that require the use of couplings for straight runs shall not be acceptable. Provide conduits as manufactured by Carlon/Thomas and Betts (Lamson & Sessions); PW Eagle; Innerduct.com; or approved equal.
- D. PVC Type EB-35 Conduit: Provide PVC type EB-35 for concrete encased installations applications only. Conduit, couplings, elbows, nipples, and other fittings shall meet the requirements of NEMA TC6 and 8, and ASTM F512 specified tests. Conduit shall be RUS listed. Provide conduits with factory formed end bells at one end. Conduits that require the

use of couplings for straight runs shall not be acceptable. Provide conduits as manufactured by Carlon/Thomas and Betts (Lamson & Sessions); PW Eagle; Innerduct.com; or approved equal.

- E. PVC Type DB—60, 100, 120]: Provide PVC type DB for direct buried installations. Conduit, couplings, elbows, nipples, and other fittings shall meet the requirements of NEMA TC6 and 8 and ASTM F512 specified tests. Conduit shall be RUS listed. Provide conduits with factory formed end bells at one end. Conduits that require the use of couplings for straight runs shall not be acceptable. Provide conduits as manufactured by Carlon/Thomas and Betts (Lamson & Sessions); PW Eagle; Innerduct.com; or approved equal.
- F. Non Metallic Conduit and Fittings - HDPE
 - 1. Underground utility duct, 4-in trade size and above, shall be high density polyethylene (HDPE) Schedule 40 conduit encased in concrete, rated for use with 90 degree C conductors and shall comply with NEMA TC-6 and 8 and ASTM F512. HDPE Conduit shall conform to NEC Article 353.
 - 2. Manufacturers for HDPE non-metallic conduits and fittings shall be:
 - a. ISCO Industries
 - b. Blue Diamond
 - c. Approved equal
- G. PVC and Fiberglass Multi-Cell Conduit Systems
 - 1. PVC Multi-cell conduit and associated fittings, couplings and expansion fittings shall be a factory assembled system consisting of three or four inner ducts, as shown on the Drawings, assembled with a protective outerduct.
 - 2. PVC multi-cell conduit and fittings shall be PVC type 40 designed and engineered for exposed, direct burial or encased underground applications. The outerduct shall have an extended 6-in integral bell end. Duct shall be marked with a longitudinal running print line indicating installation orientation (e.g. "Install This Side Up") to allow proper inner duct orientation and alignment. Duct shall have circumferential ring on spigot end of duct to ensure proper insertion depth.
 - 3. Fiberglass multi-cell conduit and fittings shall be classified as "bullet resistant, heavy duty conduit. The outer duct shall have an extended 6-in integral bell end. Duct shall be marked with a longitudinal running print line indicating installation orientation (e.g. "Install This Side Up") to assure proper inner duct orientation and alignment. Duct shall have circumferential ring on spigot end of duct to ensure proper insertion depth.
 - 4. Multi-cell conduit shall conform to NEMA TC2.
 - 5. Multi-cell conduit shall have an average outside diameter of 4.5-in.
 - 6. The inner ducts shall be manufactured from PVC to match outerduct expansion and contraction to eliminate compatibility problems.
 - 7. Dimensions of inner ducts shall be:
 - a. 3-way 1.507-in maximum I.D.
 - b. 4-way 1.194-in maximum I.D.
 - 8. Provide coupling kits, terminator kits, fittings, bends, expansion joints and accessories as required and as recommended by the manufacturer for a complete multi-cell conduit system installation.

9. Acceptable manufacturers:
 - a. Carlon/Thomas and Betts (Lamson & Sessions)
 - b. Approved equal

H. Rigid Steel Multi-Cell Conduit System

1. Rigid Steel multi-cell conduit and associated fittings, couplings and expansion fittings shall be a factory assembled system consisting of three or four inner ducts, as shown on the Drawings, assembled with a protective outerduct.
2. The outer duct shall be rigid steel designed and engineered for exposed, direct burial or encased underground applications. The outerduct shall be hot-dipped galvanized inside and out. It shall be smooth, free from burrs and coated with rust inhibitor. The outerduct shall have zipper identification marks running the length of the conduit. Each section shall be furnished with a reversing spin coupling. The coupling shall be galvanized and have set screws.
3. Multi-cell conduit shall conform to UL/6, ANSI C80.1 and NEC Article 344.
4. Multi-cell conduit shall have an average outside diameter of 4.5-in.
5. The inner ducts shall be manufactured from PVC. Expansion and contraction of the innerducts shall take place in the coupling body to eliminate compatibility problems.
6. Dimensions of inner ducts shall be:
 - a. 3-way 1.507-in maximum I.D.
 - b. 4-way 1.194-in maximum I.D
7. Provide coupling kits, terminator kits, fittings, bends, expansion joints and accessories as required and as recommended by the manufacturer for a complete multi-cell conduit system installation.
8. Acceptable manufacturers:
 - a. Carlon/Thomas and Betts (Lamson & Sessions)
 - b. Approved equal

I. Connectors, Couplings, and Fittings

1. Connectors, couplings, fittings and ancillary materials shall be by the same manufacturer as the supplied conduit.
2. End Bells: Provide PVC bell ends to fit on conduit termination points. End bells shall be installed at all termination points for mitigation of potential damage to conductor insulation during wire pulling and installation. End bells shall be smoothly tapered without sharp or rough edges to minimize chance of insulation damage.
3. End Caps: Provide PVC end caps to plug spare conduits and protect against entry of rodents, water, or dirt into the spare conduit. Provide end caps designed to fit into the end of standard conduit trade sizes and include integral cap eyelet for tying off spare conduit pull ropes or string.

2.02 IDENTIFICATION WARNING TAPE

- A. Provide underground detectable warning tape. The tape shall be constructed of solid aluminum core that is laminated with a protective clear film on both sides, sealing and

protecting the graphics from underground moisture, acids and alkalis. Tape color shall be red and be 6-inch minimum width, with black lettering, for use in trenches containing electric circuits. Use tape with printed warning "CAUTION-BURIED ELECTRIC LINE BELOW" or similar for single, telephone, fiber, network or other wiring systems.

- B. Warning tape shall be as manufactured by Seton Inc., Panduit Corporation or approved equal.

2.03 CONDUIT SPACERS

- A. Conduits installed in concrete encased ductbanks shall include spacers to provide uniform support and protection of conduits prior to concrete encasement or soil/sand backfill. The spacers shall be made of high density polyethylene and be of the interlocking module type.
- B. The spacers shall be arranged such that the centerline distance between the conduits is as shown on the Drawings
- C. Spacers shall be manufactured by Carlon/Thomas and Betts (Lamson & Sessions); Underground Devices Inc.; Formex Manufacturing, or approved equal.

2.04 CONDUIT WALL PENETRATION SEALS AND SLEEVES

- A. Refer to Section 26 05 33.

2.05 DUCT SEAL

- A. Refer to Section 26 05 33.

2.06 EXPANSION/DEFLECTION COUPLINGS

- A. Refer to Section 26 05 33.

2.07 CABLE RACKS

- A. Provide nonmetallic high load capacity cable racks for installation within manholes, handholes, or other structures. Cable racks shall consist of wall mounted stanchion with adjustable mounting locations for rack arms. Rack arms shall lock into the stanchion piece. Provide cable arms with suitable lengths for individual mounting of power cables without bundling and as appropriate for the internal dimensions of the underground structure. Cable arms shall include manufactured slots for installation of cable ties. Cable racks shall have sufficient mechanical strength for the size cables shown installed on the Drawings. Provide stainless steel mounting and anchoring hardware for installation of the cable racks. Provide cable racks as manufactured by Underground Devices Incorporated or approved equal.

2.08 MANHOLES AND HANDHOLES

- A. Provide type and size of manhole/handhole per the Handhole and Manhole Schedule included in the Drawings. Minimum size handhole provided shall be 24" x 36" internal dimensions (nominal) unless otherwise noted.
- B. Supports, pulling in irons, manhole steps and hardware shall be galvanized steel.

- C. All handholes and manholes shall have solid bottoms with sump knockouts for drainage of water.
- D. Provide extensions as required such that the depth of the handhole or manhole is coordinated with the depth of the ductbank and finished grade.
- E. Metal covers and other exposed conductive surfaces within the manhole or handhole shall be bonded per NEC Article 250. Provide grounding strap between metal cover and metal frame or other metal surface in manhole or handhole for continuity of grounding system within the manhole or handhole. Ground rods where shown on the Drawings and other grounding materials and methods shall be as specified under Section 26 05 26.
- F. Manholes and handholes shall be precast concrete, heavy duty type, designed for a HS20-44 wheel load plus the weight of the soil above (using 120 pcf for the soil weight), impact loads, and hydrostatic loads in accordance with ASTM C857. Manhole and handhole covers shall be [concrete, hinged steel, hinged steel with spring assist] and include penta head type lock-down cover bolts.
- G. Cover functional identification shall be included on every handhole and manhole cover. Identification shall be permanently engraved on the cover and shall indicate the handhole or manhole identification number as shown on the Drawings and the following as applicable:
 - 1. "Electrical" for 600V and below circuits
 - 2. "High Voltage" for medium and high voltage circuits
 - 3. "Communications" for all network systems including telephone and fiber optic cables
 - 4. "Signal" for instrumentation signals including 24VDC cables.
- H. Precast units shall be as manufactured by Oldcastle Infrastructure, Inc; Jensen Precast; or approved equal and constructed to dimensions as shown on the Drawings.
- I. Conduit Identification: Provide conduit identification tags as specified in Section 26 05 33.

PART 3 - EXECUTION

3.01 GENERAL

- A. Prior to trenching and installing underground conduits and/or underground ductbanks the Contractor shall verify field conditions and address all potential conflicts with other underground utilities, structures, or features.
- B. Protection during construction:
 - 1. Store all products in a clean, dry location prior to installation. Following installation, protect products from the effects of moisture, corrosion, and physical damage during construction. Keep openings in conduit and tubing capped with manufactured end caps during construction. Cover and protect PVC conduit, elbows, and PVC coated rigid steel conduit, nipples, elbows, and fittings from exposure to sunlight.

3.02 REQUIRED RACEWAY TYPE FOR LOCATION AND INSTALLATION METHOD

- A. Refer to Section 26 05 33.

3.03 INSTALLATION REQUIREMENTS FOR UNDERGROUND RACEWAYS

- A. General:
 - 1. Trenching, shoring, backfill, compaction, and finished exterior surfaces shall conform with the requirements of Division 31.
 - 2. Coordinate installation of underground raceways with other outside and building construction work. Maintain existing outside utilities in operation unless otherwise authorized by the Engineer.
 - 3. Remove entirely and properly reinstall all raceway installations not in compliance with these requirements.
 - 4. Union type fittings shall not be used in underground installation.
 - 5. Provide a minimum cover of 24-inches over all underground direct buried raceways or top of concrete encasement envelope unless otherwise indicated on the Drawings.
 - 6. Concrete encasement and/or backfill of underground raceways shall not commence until inspected by the Engineer.
 - 7. Warning Tape: Bury warning tape approximately 12 inches below finished grade. Align parallel to and within 6 inches of the centerline of runs that are 2 feet wide or less. Provide two tapes and align parallel to and within 6 inches of the centerline of each side of runs that are more than 2 feet wide.
 - 8. Perform bends in raceways as follows:
 - a. Except at conduit risers, accomplish changes in direction of duct runs exceeding a total of 10 degrees, either vertical or horizontal, by long utility duct sweep bends having a minimum radius or curvature of 12-1/2 feet; utility duct sweep bends may be made up of one or more curved or straight sections or combinations thereof.
 - b. For direct buried conduit, accomplish changes in direction runs exceeding a total of 10 degrees, either vertical or horizontal by using 5 degree PVC-40 couplings.
 - c. At conduit risers use manufactured bends having a minimum radius of 36 inches for ducts of 3 inches in diameter and larger.
 - 9. Install conduit seals in below grade core drilled openings or cast conduit sleeves as shown on the Contract Documents and per the submitted conduit penetration sealing submittal.
 - 10. Plug spare raceways and seal them watertight at all handholes, manholes, buildings and structures.
 - 11. Raceways installed under slab floors shall lie completely under the slab with no part of the horizontal run of the raceway embedded within the slab. Raceway shall be a minimum of 4" below the building or equipment slab.
 - 12. Install concealed, embedded, and buried raceways so that they emerge at right angles to and flush with the finished surface. None of the curved portion of the bend shall be exposed at the entry point.

13. Raceway terminations at manholes shall include end bell connectors for PVC conduit and insulated throat grounding bushings for steel conduit.
14. Patch all duct knockouts and openings in handholes with non-shrink grout.

B. Separation and Support:

1. Separate runs of two or more parallel raceways in a single trench with preformed, nonmetallic spacers designed for the purpose. Install spacers at intervals not greater than that specified in the NEC for support of the type raceways used, and in no case greater than 5 feet.
2. Support raceways installed in fill areas to prevent accidental bending until final concrete is set or backfilling/compaction is complete. Tie raceways to supports, and raceways and supports to the ground, so that raceways will not be displaced when concrete encasement or earth backfill is placed.
3. When separate parallel duct banks are shown on the Drawings, provide a minimum horizontal separation between the parallel runs.
 - a. Power ductbank (over 100 Volts ground): Provide nominal 48-inch horizontal separation between adjacent duct bank sides or as much as allowable by the physical constraints of the site.
 - b. Signal ductbank (less than 100 Volts to ground): Provide nominal 24-inch horizontal separation between adjacent duct bank sides or as much as allowable by the physical constraints of the site.

C. Arrangement and Routing:

1. Arrange multiple conduit runs substantially in accordance with applicable details shown on the Drawings. Locate and route underground conduits as indicated on the Drawings.
2. Make minor changes in location or cross section as necessary to avoid obstructions or conflicts. Where raceway runs cannot be installed substantially as shown because of conditions not discoverable prior to digging of trenches, inform the Engineer for resolution before continuing with the work. Determine precise ductbank alignment and depth as required to avoid other utilities, structures, or features.
3. Where piping systems are encountered by means of potholing or installed under this Contract along a ductbank route, maintain a 12-inch minimum vertical separation between raceways and other systems at crossings. Do not place raceways over valves or couplings in other piping systems. Refer conflicts with these requirements to the Engineer for instructions before continuing with the work.
4. Duct bank alignments shown on Drawings are diagrammatic. Actual alignments shall contain no sharp bends and shall be installed with long sweep bends. In no case shall minimum radius bends exceed values as defined in the NEC.
5. In multiple conduit runs, stagger raceway coupling locations so that couplings in adjacent raceways are not in the same transverse line.
6. Flare out incoming duct bank raceways at building walls or other structures sufficient to allow installation of conduit seals and sleeves with separation as recommended by the manufacturer. Coordinate core drill or conduit block-out locations for conduit entrances with the Structural Drawings.

- D. Direct Earth Burial Conduit Zone Backfill Installation:
1. Backfill material for the conduit zone of direct burial conduit trenches may be selected from the excavated material if free from roots, foreign material, and oversized particles in conformance with Division 2.
 2. Imported 3/4 inch minus gravel or sand may be used in lieu of material from the excavation.
 3. Provide expansion couplings on each direct buried conduit within 10 feet of entry point into directly into building cable trench subsurface space.
 4. After conduits have been properly installed, backfill the trench with specified material placed around the conduits and carefully tamped around and over them with hand tampers. Final, tamped conduit cover shall be 4-inches minimum prior to final backfill.
- E. Concrete Encasement:
1. Encase conduits in a red [reinforced] concrete envelope as indicated on the Drawings. Minimum reinforcement steel and concrete envelope shall be provided as shown on the Drawings. Concrete for ductbank encasement, where required, shall be at least 2,500 psi concrete with 1-inch maximum aggregate conforming to the requirements of Section 03 36 00.
 2. Maintain a grade of at least 4 inches per 100 feet, either from one handhole or pull box to the next, or from a high point between them, depending on the surface contour. Install raceways to drain away from buildings.
 3. Hold conduits for concrete encased raceways securely in place by acceptable window type spacer supports as specified. Where, in the opinion of the Engineer, ground conditions are such as to require concrete forms, install forms constructed of materials and in a manner acceptable to the Engineer. No variations greater than 12-inches in 50 feet will be permitted from a straight line.
 4. Envelopes may be poured directly against the sides of trenches if the cut is clean, even, and free of loose material. Remove loose material from trenches before and during pouring of concrete to ensure sound envelopes. Carefully spade concrete during pouring to eliminate all voids under and between raceways and honeycombing of the exterior surface.
 5. Do not use power driven tampers or agitators unless they are specifically designed for the application, in order to ensure that the watertight integrity of the raceways is maintained.
 6. Generally, pour an entire concrete envelope in one continuous pour. Where more than one pour is necessary, terminate each pour in a sloped plane, and insert 3/4 inch reinforcing rod dowels extending into the concrete 18 inches minimum on each side of the joint. Obtain Engineer's approval for the number and location of dowels.
 7. Where connections to existing duct lines are indicated, remove existing cables which constitute interference with the work. Excavate the lines to the maximum depth necessary. Cut off the lines and remove loose concrete from the ducts before new concrete encased ducts or handholes are installed. Provide a reinforced concrete collar, poured not less than 5-feet along the new duct line, to take the shear at the joint of the duct lines. Abandon in place those disused ducts and cables which do not interfere with the work.

- F. Backfill Installation above Conduit Zone of Direct Burial Conduit or above Concrete Envelope of Concrete Encased Conduit:
 - 1. Backfill material above the conduit zone of direct burial conduit or above concrete envelope of concrete encased conduit may be selected from the excavated material if it contains no particles larger than 3 inches in diameter and is free from roots or debris in conformance with Division 2. Imported material meeting these same requirements may be used in lieu of material from the excavation. Compact backfill in maximum 12 inch layers to at least 95 percent of the maximum density at optimum moisture content as determined by AASHTO T 180 and as specified in Division 2.

3.04 INSTALLATION REQUIREMENTS FOR HANDHOLES AND MANHOLES

- A. Install handholes, manholes, and accessories as shown on the Drawings and per the manufacture's recommendations.
- B. Final ductbank, manhole, handhole, and other structure locations and depths vary based on installed depths and underground conditions. Set manholes, handholes, and other structures at the proper elevation such that the slope of raceways shall be towards manholes and handholes and away from structures, vaults and buildings.
- C. Provide synthetic rubber expansion joint material around duct bank envelopes at entry point to structures, handholes, or manholes. Fill gaps at expansion joint between duct bank and structure, handhole, or manhole with synthetic rubber sealing compound.
- D. For duct or conduit line connections to existing manholes, handholes or splice boxes, core drill or break the manhole, handhole, or splice box wall out to the dimensions required. Preserve the steel in the wall. Provide epoxy dowels into the existing concrete of the manhole, handhole, or splice box and backfill with concrete to achieve unitized construction.
- E. Unless shown otherwise on the Drawings, the handholes and manholes shall be laid on a minimum of 12" thick crushed rock base. Install structures flush with the final finished surface in paved areas and a nominal 3-inches above the final graded surface in non-paved or landscaped areas as shown on the Drawings. Install extension rings as necessary to establish the specified elevation of the handhole or manhole top with the finished grade.
- F. Install pulling-in irons anchored to the concrete and opposite all raceway entrances to handholes or manholes.
- G. Install cable racks on opposing wall faces on each handhole and manhole. Install cable racks along the long dimension of handhole or manhole, anchored in accordance with the manufacturer's requirements.
- H. Install sump pumps where shown on the Drawings in the box sump. Where no sump pump is provided, break out the concrete at the bottom of the box sump to act as a drain.
- I. Clean and remove any excess concrete, asphalt, dirt or other material to ensure that handhole and manhole tops, lids and hatches are flush to the surface, unobstructed, and can be fully open for access. Handhole or manhole tops that are damaged, cracked, bent, or "sprung" (inoperable spring assist cover) shall be replaced at the completion of the project at no additional cost to the Owner.

- J. Handhole or manhole top identification lettering shall be clear and fully legible at the completion of the project.

3.05 PREPARATION FOR PULLING IN CONDUCTORS

- A. Do not install crushed or deformed raceways. Avoid traps in raceways. Take care to prevent the lodging of plaster, concrete, dirt, or trash in raceways, boxes, fittings, and equipment during the course of construction. Make raceways entirely free of obstructions or replace them. Ream all raceways, remove burrs, and clean raceway interior before introducing conductors or pull wires.
- B. Immediately after installation, plug or cap all raceway ends with watertight and dust-tight seals until the time for pulling in conductors.
- C. For concrete-encased raceways (after the concrete envelope has set), and for direct buried conduits, pull a mandrel through each raceway to remove debris. Pull a mandrel of a diameter approximately 1/4 inch less than the raceway inside diameter, through each raceway. Use cleanout or flexible mandrels for conduit sizes greater than 2-inches; use rubber/foam mandrel for conduit sizes 2-inches and below.
- D. For all raceways which contain less than 50 percent of the NEC allowed fill of control cables or individual conductors, install a nylon pull rope with the conductors.
- E. Unless otherwise shown on the Drawings, install conductors in lower layers of conduits in manholes or handholes leaving upper layers of conduits as spares for future conductor installations.
- F. Install plastic cable spacers or shoes on cable racks for supporting and tying off cables pulled into the structures.
- G. Installation of conductors shall conform to the requirements of Section 26 05 19 and Section 26 05 13 as applicable.

3.06 EMPTY RACEWAYS

- A. Certain raceways will have no conductors pulled in as part of this Contract. Identify with conduit tags at each end and at any intermediate pull point of each such empty raceway. Provide a fabricated, listed removable cap over each end of empty raceways. Provide a nylon pull rope with a minimum of 3-feet of slack at each end in each empty raceway. Provide cap with eyelet for attaching the nylon pull rope.

3.07 CABLE DUCT SHIELDS

- A. Provide shields where cables enter and leave manholes, handholes, and other entrances. Shields shall be of a suitable type manufactured for the purpose of protecting the cable from abrasion or other damage.

3.08 FIELD PAINTING

- A. Clean cast-iron frames and covers not buried in masonry or mortar of mortar, rust, grease, dirt, and other deleterious materials, and give a coat of bituminous paint. Clean steel frames not buried in masonry and steel covers of mortar, dirt, and grease by an approved blasting process. Clean surfaces that cannot be cleaned satisfactorily by blasting process. Clean

surfaces that cannot be cleaned satisfactorily by blasting by wire brushing or other mechanical means to bare metal. Wash surfaces contaminated with rust, dirt, oil, grease, or other contaminants with solvents until thoroughly cleaned.

- B. Immediately after cleaning, coat surfaces with a pretreatment coating or give a crystalline phosphate coating.
- C. As soon as practicable after the pretreatment coating has dried, prime treated surfaces with a coat of zinc chromate primer and one coat of synthetic exterior gloss enamel as described in Division 9.
- D. Rigid galvanized steel conduits buried in earth or encased in concrete shall be completely painted with bitumastic based coating.

3.09 IDENTIFICATION

- A. Provide engraved conduit identification tags at each underground structure as specified in Section 26 05 33.

3.10 RECONDITIONING OF SURFACES

- A. Restore paved and unpaved surfaces disturbed during the installation of duct or conduit to their original elevation and condition in accordance with Division 32.

END OF SECTION

SECTION 26 05 73

ELECTRICAL SYSTEM ANALYSES

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Perform electrical analyses using computer based electrical modeling software. Submit summary reports of the results of the analyses and use these results as the basis for final equipment settings and adjustments, system documentation, and labeling. All new, modified, and existing equipment shall be included in the electrical analyses as specified herein.
- B. Studies to be performed shall include:
1. Short-circuit
 2. Coordination Studies.
 3. Arc Flash Hazard Studies
 4. Harmonic Analyses
- C. Provide all material, equipment, labor, and technical supervision to perform electrical studies.
- D. The term "major electrical equipment" when used in this Section shall include all equipment operating above 480V and other equipment specified in this Section, including but not limited to:
1. New Motor Control Centers
 2. Existing and modified Motor Control Centers
 3. New motors and drives
 4. Distribution dry-type transformers and lighting panels
 5. Other equipment as necessary to comply with the coordination and arc flash requirements as specified in these Specifications and as per applicable standards and industry recommended practices.
- E. Results of the final electrical system studies shall be used to establish protective device settings, protective device programming, arc flash label documentation, and other requirements of the electrical system testing and commissioning procedures specified in Section 26 08 00.

1.02 RELATED SECTIONS

1. Section 26 05 00 – Common Work Results For Electrical
2. Section 26 08 00 – Commissioning of Electrical Systems

1.03 SUBMITTALS

- A. All submittals shall be in accordance with Sections 01 33 00 and 26 05 00

- B. Submit Electrical Equipment Analyses Plan a minimum of four (4) weeks after award of contract. Submittal shall include the following at a minimum:
1. Qualifications of firm or individual(s) proposed to perform the analytical studies confirming that the specified qualifications are met including professional engineering registration and experience requirements.
 2. Details of software analytical software proposed for performing the studies including technical details illustrating compliance with referenced standards and protocols.
 3. Resume of Professional Engineer and/or lead electrical modeler responsible for the technical approach and accuracy of the finished studies. Resumes shall include details of professional registration of the Engineer in Responsible Charge for the studies, educational background, relevant software training, and experience performing electrical modeling studies for systems of equal or more complexity.
 4. Proposed equipment and/or bus naming conventions to be used for the electrical analyses prior to preparation of the computer model. Bus naming shall reference and/or incorporate electrical equipment naming conventions shown on the Drawings.
 5. Schedule of Electrical Analytical Studies prepared using Microsoft Project, including:
 - a. Dates of major electrical equipment shop drawing and product submittals
 - b. Dates of electrical data acquisition and data requests to the Owner
 - c. Dates of electrical model development
 - d. Dates of submittal and Engineer review of all electrical analytical study reports
 - e. Dates of re-submittal and Engineer review of all electrical analytical study reports
 6. Representative samples of analytical reports for short circuit studies, coordination studies, arc flash studies, and harmonic studies indicating conformance with the specified study requirements.
- C. Submit electrical study reports including results for short circuit and coordination, arc flash, and harmonic analyses a minimum of twelve (12) weeks prior to scheduling any field testing.
- D. Following submittal and favorable review of the studies, submit electronic copies of final reports and electronic copies of the final analytical databases in native format for the analytical package used for the analyses. Database shall be submitted on CD-ROM, thumb drive or other mass storage device. Final report shall include settings and results used to establish protective device field settings and content of arc flash labels provided for the Project.
- E. Incorporate electrical study results as part of the O&M Manuals per Section 01 78 23 and as required per NFPA 70E for Arc Flash Labeling documentation.

1.04 REFERENCE STANDARDS

- A. All analyses shall be in accordance with the following codes and standards.

1. American National Standards Institute
 - a. ANSI C2 – National Electrical Safety Code
 - b. ANSI C.37.010 – Standard Application Guide for AC High-Voltage Circuit Breaker
 - c. ANSI C37.5 – Calculation for Fault Currents for Application of Power Circuit Breaker
 - d. ANSI C37.13 – Low-Voltage AC Power Circuit Breaker (600-Volt Insulation Class)
 2. Institute of Electrical and Electronic Engineers - IEEE
 - a. IEEE 141 – “Recommended Practice for Electrical Power Distribution for Industrial Plants”
 - b. IEEE 242 – “Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems”
 - c. IEEE 399 – “Recommended Practice for Industrial and Commercial Power System Analysis”
 - d. IEEE 519 – “Recommended Practice and Requirements for Harmonic Control in Electrical Power Systems”
 - e. IEEE 1584 – “Guide for Performing Arc-Flash Hazard Calculations”
 3. InterNational Electrical Testing Association
 - a. NETA ATS – Acceptance Testing Specifications (latest edition)
 4. National Fire Protection Association - NFPA
 - a. ANSI/NFPA 70: National Electrical Code
 - b. ANSI/NFPA 70B: Electrical Equipment Maintenance
 - c. NFPA 70E: Standard for Electrical Safety in the Workplace
 - d. ANSI/NFPA 101: Life Safety Code
 5. Occupational Safety and Health Administration - OSHA
 - a. OSHA 29-CFR, Part 1910 Subpart S - Electrical
 6. Other applicable State and local codes and ordinances
- B. Where reference is made to one of the standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALIFICATIONS

- A. The electrical analytical studies shall be performed by a registered professional electrical engineer in the state of California with a minimum of five years' experience in the

performance of such studies. Engineer shall have attended standard training sessions on the analytical package specified for use on this Project.

1.06 ELECTRICAL SYSTEM ANALYSES WORKSHOP

- A. The Contractor shall schedule and hold an electrical system analysis coordination meeting prior to performing any technical development or modeling. The meetings shall include as a minimum the Owner's representative, the Contractor, the electrical subcontractor, and representative of the electrical system analyses firm. Meetings will be held at the Pittsburg Water Treatment Plant site.
- B. Prepare and distribute an agenda for the meeting a minimum of one week before the scheduled meeting date for review and comment by the Owner. Each meeting will last up to four (4) hours total length. Facilitate the meeting and submit draft meeting minutes for review by the Owner followed by final meeting minutes incorporating review comments and distribution to all attendees. Contractor shall be responsible for coordinating attendance of all non-City personnel including all Contractor staff and utility representatives.
- C. System Analyses Workshop: The meeting shall be held no less than 30 calendar days following Notice To Proceed. The purpose of the meeting shall be to allow the Contractor to request specific data, data files, and information. The Contractor shall prepare a comprehensive plan for performing the analysis including acquisition of required data, coordination with equipment suppliers, demonstration of an understanding of the protection schemes shown on the Contract Documents, demonstration of an understanding of the utility interconnection requirements, and method for arc flash analysis and labeling. At the meeting the Contractor shall summarize understanding of the project describe proposed analytical techniques, present a preliminary schedule showing key project elements and milestone dates, and request any additional information required from the Owner.

1.07 FINAL SYSTEM DOCUMENTATION

- 1. Incorporate final versions of electrical analyses reports and studies into the project operations and maintenance manuals as specified under Sections 01 78 23 and 26 05 00.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 ELECTRICAL ANALYTICAL STUDIES

- A. General
 - 1. All analyses in the study shall be performed using [SKM Power*Tools ©][ETAP ©][EasyPower ©], with required bus capabilities and analytical add-on modules as necessary to facilitate a comprehensive analysis of the electrical system as shown on the Drawings.
 - 2. The database for the study to be performed under this Contract shall match nomenclature and identification approaches used on the Drawings and as submitted by the Contractor.

3. The final electronic database and library for the approved final study shall be submitted to the Engineer on CD, thumb drive or other mass storage device in the native format of the analytical package used for the study. Construction Manager and Engineer will verify compatibility of CD submitted files with the SKM software provided under this Section.
- B. The study shall be in full compliance with applicable ANSI and IEEE Standards.
- C. The firm performing the study shall be responsible for obtaining any and all data required to complete the study and determine recommended setpoints. Data to be obtained shall include available utility short circuit duty; utility protective device make, model, and setting; all new and existing equipment characteristics and ratings; feeder sizes and lengths; new and existing loads and motor characteristics; and all other input data necessary to complete the study per the requirements of this Section.
- D. Record drawings and other information of the existing electrical distribution system will be made available upon request from the Owner after Notice of Award. However, the accuracy of the existing documentation has not been confirmed. Contractor shall be responsible for field verification of all new and existing input data used for the study to achieve an accurate and comprehensive model of the electrical distribution system.
- E. All studies shall be stamped and signed by a Professional Electrical Engineer currently registered in California.

3.02 SHORT CIRCUIT AND PROTECTIVE DEVICES COORDINATION STUDY

- A. Provide a complete short circuit study and protective device coordination study for the power distribution system including both modified existing and new system elements. The study shall include the following major components:
 1. New Medium Voltage distribution system, switchgear, protective devices, transformers, and other medium voltage equipment provided under this Contract including relay protection schemes for system coordination and safety, standby generator, and automatic source transfer controls
 2. New and existing 480V switchgear. Study shall include analysis of all new and existing buses, loads, and protective devices including implementation of relay protection scheme for system coordination and safety.
 3. New MCC, distribution switchboards, and motor controllers.
 4. All existing MCCs. MCCs modified under this Contract shall be analyzed with the changes detailed in the Contract Documents. Obtain existing protective device settings in existing equipment to develop settings for system coordination and safety.
 5. New and existing motors and drives; individual motors larger than 50hp. Motors smaller than 50hp may be modeled as combined or composite loads as defined in ANSI C37.010 and C37.5.
 6. Existing standby generator including associated circuit breakers, relaying, and other protective devices.
 7. New standby generator including associated circuit breakers, relaying, and other protective devices.
 8. Distribution dry-type transformers and lighting panels

9. Other equipment as necessary to comply with the coordination and arc flash requirements as specified in these Specifications.

B. The study shall at a minimum:

1. Present the overall electrical distribution single line diagram including utility, generators, transformers, cables, motor control centers, VFDs, and all other source and end use equipment included in the limits of the study. The diagram shall identify each bus, transformer, reactor, etc., by name and corresponding node number using the approved bus tagging scheme. The available fault currents, and X/R ratio for each node, shall be indicated on the diagram. The single line diagram shall include cable sizes, lengths, transformer voltage, and transformer kVA.
2. Document available three phase and ground fault asymmetrical and symmetrical fault currents at each piece of electrical equipment, bus, transformer, etc.
3. Provide a system impedance diagram. The diagram shall include the power company's impedance and X/R ratio, circuit element impedances (e.g. transformers, generators, motors, VFDs, feeders, distribution buses, etc.).
4. Identify and list the available fault current at each bus confirming the short circuit duty is within the limits of the equipment.
5. List the momentary and interrupting rating of all elements of the distribution system. The maximum available fault current available at each element shall be calculated.
6. Determine the adequacy of the electrical protective devices to withstand the maximum available fault at the terminals of the equipment. Provide an equipment list, the equipment rating (both momentary and withstand), the maximum available fault rating and the adequacy of the equipment to withstand the fault. Equipment that does not have adequate ratings shall be identified immediately and brought to the attention of the Engineer.
7. Provide a complete set of time-current coordination curves on log paper. Limit the number of protective devices shown on any drawing to a maximum of four. A single line diagram depicting the portion of the distribution system under study shall appear with the curve. The minimum size log paper to be submitted shall be 11.5-in by 18-in.
8. Prepare time current plots including transformer ANSI damage and inrush points, cable damage curves, motor damage curves, capacitor damage curves, generator damage curves, circuit breaker and fuse ratings and settings, protective relay settings and any other information required by ANSI and good design practices. At a minimum provide curves for:
 - a. Time current curves demonstrating system coordination and selectivity under normal operation as well as modified or altered curves reflecting the impact of any arc flash mitigation strategies included in the design. Assumption made for pickup or timing alterations as part of arc flash mitigation schemes shall be clearly documented on the relevant time current curves.
 - b. Utility protective device to service entrance main circuit breaker.
 - c. Each low voltage feeder down to 480 Volt main switchboard, motor control center, variable frequency drives or other end use device.

- d. Each main and worst-case representative feeder circuit breaker(s) located in the 480 Volt main switchboard, motor control center, variable frequency drives, or other end use device.
 - e. Each ground fault protective device provided for 480 Volt or 208V distribution systems.
 - f. Motor starting profile for the largest motor connected to the main distribution point.
 - g. Transformer damage curves in accordance with ANSI C57.109.
 - h. Transformer excitation current
 - i. Motor, generator and cable damage curves in accordance with the manufacturer's recommendations.
- 9. Develop a complete set of coordination curves for every protective relay, circuit breaker, fuse, timer, etc., serving or located in the electrical equipment furnished for the project including the utility protective devices.
 - 10. Summarize protective device settings for every over current protective device, timer, power system relay (e.g. ANSI 25, 27, 32, etc.), circuit breaker, recommended fuse and current transformer ratings, etc.
 - 11. Recommend final relay and settings for implementing the coordination and protection scheme. Define specific relay types and protective features (i.e. inverse, very inverse, extremely inverse, over current with or without voltage restraint, timers, etc.), current transformer ratings and types, fuse, residual or zero sequence connected ground fault protection, etc., that will allow the system to be protected within the equipment fault ratings and provide the maximum possible coordination between the protective devices.
 - 12. Prepare an executive summary describing the distribution system, the procedures used to develop the study, utility related information furnished by the utility company including the name and telephone number of the individual supplying the information, identify all assumptions made in the preparation of the study, identified any problem areas and provide a definitive statement concerning the adequacy of the distribution system to interrupt and withstand the maximum possible fault current.
 - 13. Generate PDF files or printouts of all input data
 - 14. Generate PDF files or printouts for the three phase, single phase and ground fault studies. Printouts shall indicate the fault current available at each major equipment and distribution bus.
 - 15. Generate PDF files or printouts of tables listing all the electrical distribution and utilization equipment, the equipment interrupting and withstand ratings, the available fault current at the terminals of the equipment and the ability of the equipment to interrupt and/or withstand the fault.
- C. Prepare a short circuit and system coordination report coordinated with the approved submitted equipment shop drawings. The report shall confirm equipment is being applied within design ratings and electrical protective devices will coordinate.
- 1. Provide recommended coordination settings for all protective devices.

2. Provide recommended settings for the arc flash sensor-based protection scheme for the MV Switchgear.
3. Provide recommended settings for the zone protective interlocking protection scheme for the 480V Switchgear.
4. The coordination study shall be submitted in PDF format or hardcopy bound in a standard 8-1/2-in by 11-in format, 3-hole punch binder. The selection of all protective relay types, current transformers, fuse types, and ratings shall be the responsibility of the equipment manufacturer or system integrator and shall be based on the preliminary draft of the coordination study.
5. The complete study shall be favorably reviewed by the Engineer before any equipment is shipped.

3.03 ARC FLASH HAZARD STUDY

- A. Perform an arc flash hazard study after the short circuit and protective device coordination study has been completed. The arc flash hazard study shall include operation during normal conditions alternate operations, emergency power conditions, and any other operations, which could result in maximum arc flash hazard.
- B. Perform the arc flash hazard analysis for all equipment (including 120V control panels) provided or modified under this Contract having a nominal operating voltage greater than 50 Volts AC to ground as required per NFPA 70E.
- C. Arc flash hazard analysis need not be based solely on results of the computerized electrical distribution system model. However, if other alternative methods as allowed under NFPA 70E are used for the hazard analysis, provide complete documentation, details, and calculations used for establishing the resulting arc flash hazards.
- D. Pertinent data, rationale employed, and assumptions in developing the calculations shall be incorporated in the report.
- E. The study shall be prepared in accordance with applicable NFPA 70E, OSHA 29-CFR, Part 1910 Sub part S and IEEE 1584 Standards.
- F. The study shall include as a minimum the following:
 1. Flash Hazard Protection Boundary
 2. Limited Approach Boundary
 3. Restricted Boundary
 4. Prohibited Boundary
 5. Incident Energy Level or required Personal Protective Equipment Class
 6. Type of Fire Rated Clothing
- G. Submit Arc Flash Warning labels listing items above for all equipment analyzed in the study. Labels shall include the bus name and voltage. Provide permanent thermal transfer type, factory manufactured labels in conformance with NFPA 70E and ANSI Z535. Labels shall be made of high adhesion polyester and have electronic generated characters with no field markings. Labels shall be printed in color.
- H. Produce individual Bus Detail sheets for each location where an Arc Flash Warning label is provided. The sheets shall list the items from above and the following additional items:


1. Bus Name
2. Upstream Protective Device Name, Type, and Settings
3. Bus Line to Line Voltage

I. Produce Arc Flash Evaluation Summary Sheet listing the following additional items:

1. Bus Name
2. Upstream Protective Device Name, Type, and Settings
3. Bus Line to Line Voltage
4. Bus Bolted Fault
5. Protective Device Bolted Fault Current
6. Arcing Fault Current
7. Protective Device Trip / Delay Time
8. Breaker Opening Time
9. Solidly Grounded Column
10. Equipment Type
11. Gap
12. Arc Flash Boundary
13. Working Distance
14. Incident Energy
15. Required personal protective equipment (PPE) blast rated clothing energy rating or protection class

J. The complete study and arc flash warning label design shall be submitted and approved by the Engineer at least 30 Days prior to energizing the electrical equipment.

K. Submit the arc flash label design for approval. At a minimum, label shall contain details as shown in the Sample Arc flash label below.

 WARNING			
Arc Flash and Shock Risks! Appropriate PPE Required. Failure to comply can result in Death or Injury!			
Arc Flash Boundary	39 inches	Shock Risk	480 VAC
		Arc Flash Incident Energy at 18 inches	4.20 cal/cm²
<small>Changes in Equipment Settings, System Configuration, or Utility Service may invalidate the calculated values and PPE Requirements.</small>			
<small>Note 1: Hazard levels are valid for Normal/Utility Operation only; Contact agency' safety officer prior to performing any energized work while under Generator Operation.</small>			
<small>Note 2: Follow agency' standard LOTO Operation procedures prior to performing any Work.</small>			
Location: DP-1 Prot. Device: BKR-DP-1			
<small>Company Logo</small>	<small>Company Name:</small>	<small>Company Address:</small>	<small>Phone:</small>
<small>Job # 000001 -</small>	<small>Job Details</small>	<small>Label prepared By: _____</small>	<small>Date: Sep 25, 2018</small>

3.04 HARMONIC ANALYSIS STUDY

- A. System Harmonics:
 - 1. System Study A: Perform a system-wide harmonic analysis incorporating all new and existing harmonic sources connected to the existing Switchgears, SWGR-XXX.
 - 2. System Study B: Perform a system-wide harmonic analysis incorporating all new harmonic sources connected to the new Switchgear, SWGR-XXX.
 - 3. All harmonic analyses shall use the source switchgear, switchboard, or MCC bus providing 480V power to the modeled harmonic sources
- B. Source Power:
 - 1. Perform studies under both utility and standby generator power.
 - 2. Perform studies for the existing switchgear, under both utility and standby generator power from the existing standby generator. Existing standby generator study parameters shall be provided by the Owner after Notice to Proceed.
- C. Perform studies with the harmonic mitigation devices shown on the Contract Documents. If additional harmonic mitigation equipment beyond that provided under this Contract immediately notify the Owner. If additional harmonic mitigation equipment beyond that provided under this Contract due to the Contractor's equipment selection process, provide such equipment including all interconnecting conduit, wire, mounting, CTs, PTs, etc. at no additional cost to the Owner.
- D. Calculations shall use the value of available short circuit current obtained from the utility company, and equipment parameters for generator, transformer, protective devices, other equipment provided under this Contract. Prepare calculations using feeder sizes and lengths as shown on the Drawings.
- E. Individual and total voltage and current distortion at the indicated point of common coupling shown on the Drawings shall meet requirements of IEEE 519 for General Systems. The Contractor shall note that the power quality measurement location as established under these Contract Documents does not necessarily meet the formal definition of the Point of Common Coupling (PCC) found in IEEE Recommended Practice 519 (2022).
- F. Submit harmonic report in an 8-1/2x11 inch binder, 3 hole punched. Oversized sheets such as system single line diagrams shall be limited to 11x17, z-folded into the binder as required to ensure legibility. Include match lines or other means to present the entire system single line diagram using the 11x17 sheets specified. Minimum font size shall be 6 point.
- G. Analysis report shall include at a minimum:
 - 1. Sections clearly and logically organized with a table of contents. Electronic submittals shall include PDF bookmarks or similar navigational tools to allow direct access to each main section and subsection.
 - 2. An executive summary section with assumptions and recommendations.
 - 3. All input data and assumptions.
 - 4. Explanation of the study results with specific recommendations on filters or other measures required to meet the specified limits.
 - 5. Individual equipment voltage and current harmonic content and distortion levels up to and including the 31st harmonic, at the combined total harmonic content as a

percent of the 60HZ fundamental under the load conditions specified and point of common coupling indicated.

6. A system impedance diagram based on the electrical one-line diagrams included in the Drawings. Diagram shall clearly indicate impedance values used for the study and relate directly back to circuit and load identifications and callouts used on the Contract Documents.
 7. Utility component representing available short circuit current and X/R ratio from the electric utility.
 8. Point of common coupling.
 9. All non-linear loads shown individually for equipment greater than 10hp including variable frequency drives, UPS, and AC to DC conversion equipment. Harmonic source models developed for each nonlinear load type. The load characteristics/harmonic spectra shall be determined or approximated based on the ultimate equipment provided and used as harmonic sources for the computer simulations.
 10. All linear loads in switchgear, switchboard, motor control centers, distribution panels/panelboards may be modeled as a lump sum.
 11. Bus tagging per the approved bus identification scheme.
 12. Copies of manufacturer data on harmonic spectrum produced by each non-linear load in the system. Incorporate VFD equipment characteristics per Section 26 29 23 and 26 33 00.
 13. Single line diagram showing total demand distortion for each impedance element and total harmonic distortion for each bus along with the individual harmonic frequency components. Report shall indicate compliance or non-compliance with applicable sections of IEEE 519 Standard.
 14. Voltage waveforms, harmonic spectrum, and frequency response plots at the point of common coupling.
 15. Recommendations for mitigating the total harmonic voltage distortion or total current demand distortion on the system if the combination of loads exceeds or violates the specified limits.
 16. Recommendations for mitigating the impact of the harmonic distortion on plant equipment or processes if the levels are such that equipment or processes may be impaired.
- H. Should the results of the harmonic analysis reveal non-compliance with the specified IEEE-519 requirements, provide suitable harmonic mitigation equipment such as active filters, passive filters, regulators, or other equipment as required to achieve the specified conformance. Additional harmonic analyses shall be performed as required to demonstrate conformance with the required harmonic limits. Additional analyses and harmonic mitigation systems including hardware, installation, protective devices, conduit and wire shall all be provided at no additional cost to the Owner.

END OF SECTION

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SECTION 26 05 80

LOW VOLTAGE MOTORS

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Provide three-phase and single-phase AC induction motors 600V or less, rated 500HP or less and operating at greater than 75% load for equipment as shown on the Contract Documents.
- B. Provide all motor accessories, features, and enclosures as specified herein.
- C. Motors furnished under other Sections, shall be in conformance with the requirements listed in this Section unless otherwise noted in the detailed technical specifications included in Division 11 and 15.

1.02 RELATED SECTIONS

- 1. Section 26 05 00 – Common Work Results for Electrical
- 2. Section 26 05 26 – Grounding and Bonding for Electrical Systems

1.03 SUBMITTALS

- A. Submittals shall be in accordance with Sections 01 33 00 and 26 05 00.
- B. Submittal of motor data shall include complete nameplate data and test characteristics in accordance with NEMA Standard MG1 Part 12 and, in addition, the following for motors typical of the units furnished:
 - 1. Efficiency at 1/2, 3/4 and full load
 - 2. Power factor at 1/2, 3/4 and full load
 - 3. Motor outline, dimensions and weight
 - 4. Descriptive bulletins, including full description of insulation system
 - 5. Bearing design data
 - 6. Special features (i.e., space heaters, temperature detectors, etc.)
 - 7. Power factor correction capacitor rating, type, and mounting method
 - 8. Dimensional drawings for each item of couplings and motor to be furnished for motors to be replaced under this Contract
- C. Submit method and equipment for grounding shaft rotors for motors powered by PWM variable frequency drives.
- D. For inverter duty rated motors, provide certification that the motor is in compliance with NEMA MG-1, Part 31.

1.04 REFERENCE STANDARDS

- A. Institute of Electrical and Electronics Engineers (IEEE):
 - 1. IEEE 43: IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery

2. IEEE 841: IEEE Standard for Petroleum and Chemical Industry – Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors – Up To and Including 370 KW (500 HP).
 3. IEEE 112: Standard Test Procedure for Polyphase Induction Motors and Generators.
 4. IEEE 114: Standard Test Procedures for Single-Phase Induction Motors.
- B. National Electrical Manufacturers Association (NEMA):
1. NEMA MG1: Motors and Generators
- C. American Bearing Manufacturers Association (ABMA)
1. ABMA 20: Radial Bearings of Ball, Cylindrical Roller, and Spherical Roller Types – Metric Design

1.05 QUALITY ASSURANCE

- A. Where motors are specified under the technical specifications as “Severe Duty” they shall be designed and manufactured in accordance with the latest version of IEEE Standard 841.
- B. Unless noted otherwise herein, routine tests shall be performed on representative motors in accordance with IEEE Standard 112, and shall include the information described in NEMA MG1-Part 12 and manufacture’s standard testing. Efficiency shall be determined in accordance with IEEE Publication No. 112, Method B. Power factor shall be measured on representative motors. Certification shall be provided that motors have passed the factory tests.
- C. Where motors are specified as “Critical” or otherwise called for under the process equipment technical specifications the manufacturer shall provide complete manufacturer’s testing on the specific motors provided under this Contract. Test results of representative motors from a manufactured group of motors shall not be acceptable. Submit specific test reports for the specific motors including the motor serial number on certified test forms. The complete test shall be done per the requirements of the manufacture’s standard factory test.

PART 2 - PRODUCTS

2.01 RATING

- A. Each motor shall develop ample torque for its required service throughout its acceleration range at a voltage 10 percent below nameplate rating. Where shown on the Drawings to be operated on a reduced voltage starter, the motor shall develop ample torque under the conditions imposed by the reduced voltage starting method.
- B. All motors shall be rated for continuous duty suitable for operation in a 40 degrees C ambient and not less than minus 15 degrees C with altitudes less than 1,000 meters unless otherwise noted.
- C. Motors shall be rated for frequency variation within plus/minus 5%.
- D. Specific motor data such as HP, rpm, enclosure type, etc, are specified under the detailed specification for the equipment with which the motor is supplied.
- E. Provide motors 1 horsepower and above with service factor of 1.15 at 40°C under sinusoidal operation unless specifically noted otherwise.
- F. Motors specified for operation under variable frequency drives shall be inverter duty rated in compliance with NEMA MG-1, Part 31 and shall have a nameplate service factor of 1.15 (sinusoidal operation) and 1.0 when driven from a non-sinusoidal source.

2.02 ENCLOSURES

- A. Motors specified herein will conform to one of the following NEMA standard enclosure designs:
1. Open Drip Proof (ODP): Motor shall be constructed with ventilated openings such that drops of liquid and solid particles striking or entering the enclosure at any angle 0 – 15 degrees downward from vertical do not interfere with the successful operation of the motor.
 2. Weather Protected Type I (WPI): A weather-protected Type I machine is a guarded machine with its ventilating passages so constructed as to minimize the entrance of rain, snow and air-borne particles to the electric parts.
 3. Weather Protected Type II (WPII): A weather-protected Type II machine shall have, in addition to the enclosure defined for a weather protected Type I machine, its ventilating passages at both intake and discharge so arranged that high velocity air and air-borne particles blown into the machine by storms or high winds can be discharged without entering the internal ventilating passages leading directly to the electric parts of the machine itself. The normal path of the ventilating air which enters the electric parts of the machine shall be so arranged by baffling or separate housings as to provide at least three abrupt changes in direction, none of which shall be less than 90 degrees. In addition, an area of low velocity not exceeding 600 feet per minute shall be provided in the intake.
 4. Totally enclosed fan cooled (TEFC) Motors shall have a steel or cast iron frame, cast iron end brackets, cast iron conduit box, drain holes (corrosion resistant plugs for frames 286T and smaller and automatic breather/drain devices for frames 324T and larger) and upgraded insulation by additional dips and bakes to increase moisture resistance. Fan for cooling the motor shall be integral.
 5. Totally enclosed non-ventilated (TENV): Motors shall include the same rating and accessories as specified for TEFC motors except that the frame surface is cooled by convection only.
 6. Totally enclosed Water Air Cooled (TEWAC): A totally enclosed air-to-water-cooled machine is a totally enclosed machine which is cooled by circulating air which, in turn, is cooled by circulating water. It is provided with a water-cooled heat exchanger, integral (IC7_W) or machine mounted (IC8_W), for cooling the internal air and a fan or fans, integral with the rotor shaft (IC_1W) or separate (IC_5W) for circulating the internal air.
- B. Motors shall have a steel or cast iron frame and a cast iron or stamped steel conduit box.
1. Conduit box shall be split from top to bottom and shall be capable of being rotated to four positions.
 2. Synthetic rubber-like gaskets shall be provided between the frame and the conduit box and between the conduit box and its cover.
 3. Where available for the enclosure type specified, motor leads shall be sealed with a non-wicking, non-hygroscopic insulating material.
 4. A frame mounted pad with drilled and tapped hole, not less than 1/4-in diameter, shall be provided inside the conduit box for motor frame grounding.

2.03 SEVERE DUTY

- A. Where motors are specified to be "Severe Duty" per the technical specifications they shall be of the corrosion resistant type conforming to motors designated by the manufacturer as "Corro-Duty", "Mill and Chemical", "Custom Severe Duty", or similar quality designation. Severe duty motors shall have a cast iron frame, cast iron end brackets, cast iron conduit

box, tapped drain holes (corrosion resistant plug for frames 286T and smaller and automatic breather/drain devices for frames 324T and larger).

- B. Motors shall be single speed, totally-enclosed fan-cooled (TEFC), squirrel-cage polyphase induction motors.
- C. Where fractional horsepower motors are specified in the process equipment specifications or shown on the Drawings for applications requiring severe duty motors, provide nominal 1 horsepower severe duty motor conforming to manufacturer's standard severe duty equipment.

2.04 SPECIAL PURPOSE MOTORS

A. Submersible motors:

1. The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180°C (356°F). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The stator shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable. The use of pins, bolts, screws or other fastening devices used to locate or hold the stator and that penetrate the stator housing are not acceptable. The motor shall be designed for continuous duty while handling pumped media of up to 104°F. The motor shall be capable of no less than 15 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of aluminum.
2. Three thermal switches shall be embedded in the stator end coils, one per phase winding, to monitor the stator temperature. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection.
3. The motor shall include a moisture sensor that will detect when moisture has entered the stator and lower oil seal housing. The sensor shall send an alarm to a control panel, motor control center or as shown on the drawings.
4. The power and control cable entry shall be designed to provide a positive leak-free seal to prevent liquid from entering the air filled motor housing. Cable type shall be SEOW-A or Equal and be UL Listed for submersible use in sewage water.
5. The junction chamber shall be sealed off from the stator housing and shall contain a terminal board for connection of power and pilot sensor cables using threaded compression type terminals. The use of wire nuts or crimp-type connectors is not acceptable.
6. The motor shall be explosion proof, TENV design and be certified for Class 1, Division 1, Groups C & D by Factory Mutual (FM).

B. Explosion proof motors

1. Explosion proof motors shall have a cast iron frame, cast iron end brackets, cast iron conduit box, 1.15 service factor at 40 degrees C, tapped drain holes (corrosion resistant plugs for frames 286T and smaller and automatic breather/drain devices for frames 324T and larger) and be UL listed for Class 1, Div. 1, Group D hazardous areas.

2.05 NAMEPLATES

- A. Provide motor manufacturer's nameplates engraved or embossed on stainless steel and fastened to the motor frame with stainless steel screws or drive pins. Nameplates shall indicate clearly all of the items of information enumerated in NEMA Standard MG1-10.38 or MG1-20.60, as applicable.

2.06 CONDENSATION HEATERS

- A. Provide condensation winding space heaters for every 3-phase motor provided under this Contract unless specified otherwise under the detailed equipment specifications. Heaters shall be of the cartridge or flexible wrap around type installed within the motor enclosure adjacent to core iron. Heaters shall be rated for 120 Volt, single phase with wattage as required or as recommended by the motor manufacturer for the specific application. The heater wattage and voltage shall be embossed on the motor nameplate. Power leads for heaters shall be brought out at the motor lead junction box or auxiliary termination box if available.

2.07 TEMPERATURE DETECTORS

- A. Provide stator winding temperature detectors for all motors 200 hp and larger, all motors 40 hp and larger when driven by variable speed drives, where specified under the detailed mechanical specifications for individual equipment, or where shown on the Drawings.
- B. [Provide factory installed, embedded, bi-metallic switch type. Device shall protect the motor against damage from overheating caused by single phasing, overload, high ambient temperature, abnormal voltage, locked rotor, frequent starts or ventilation failure. The switch shall have normally closed contacts. Not less than three detectors shall be furnished with each motor.]
- C. [Provide 100 ohm platinum RTD's, two in each phase, six per winding, symmetrically installed between stator coils where highest temperature will occur based on the manufacturer's recommendation and standard construction. One set in each phase shall be operational and one set as designated spares. Temperature monitoring shall be in the [starter, VFD, motor protection relay, condition assessment system, as shown on the Drawings.]]
- D. Detector leads shall be terminated in the motor main conduit termination box or auxiliary termination box on the motor frame if available.

2.08 SINGLE PHASE MOTORS

- A. Unless otherwise specified, motors smaller than 1/2 Hp shall be single phase, capacitor start. Small fan motors may be split-phase or shaded pole type if such are standard for the equipment. Wound rotor or commutator type single-phase motors are not acceptable unless their specific characteristics are necessary for the application.
- B. Single-phase motors shall be rated for operation at 115 Volts, 208 Volts, or 240 Volts, single phase, 60 Hz, as shown on the Drawings.
- C. Locked rotor current shall not be greater than specified in NEMA Standard MG1, Part 12, Design "N".
- D. Motors shall be totally enclosed in conformance with NEMA Standard MG1, Part 1. Small fan motors may be open type if suitably protected from moisture, dripping water and lint accumulation.
- E. Motors shall be provided with sealed ball bearings lubricated for 10 years normal use.
- F. Motors shall be by Nidec-U.S. Motors; Baldor; GE Motors (ABB); or equal.

2.09 THREE PHASE MOTORS-FRAMES 143T THROUGH 449T

- A. General
 - 1. Unless otherwise specified, motors 1/2 Hp and larger shall be 3 Phase, squirrel cage induction type, premium efficiency.

2. All motors 3/4 Hp and larger shall be a NEMA frame 143T or larger. 1/2 Hp motors and 3/4 Hp motors rated 1800 and 3600 rpm, shall be a 56 frame. Motors shall be designed and connected for operation on a 480 Volt, 3 Phase, 60 Hz alternating current system. Dual voltage (230/460) rated motors are acceptable.
3. Unless otherwise required by the load, all motors shall be NEMA Design B, normal starting torque. Locked rotor kVA/Hp shall not exceed Code Letter G as described in NEMA Standard MG1-10.37 for motors 20 Hp and larger.
4. Where available for the application or where specified as severe duty in the detailed technical process equipment specifications, motors one horsepower and above shall meet or exceed the requirements of IEEE 841.
5. Motors with a 180 frame and larger shall have provisions for lifting eyes or lugs capable of a safety factor of 5.
6. Motors shall be by Nidec-U.S. Motors; Baldor; GE Motors (ABB); or equal.

B. Bearings

1. Anti-friction motor bearings shall be designed to be regreasable and initially shall be filled with grease suitable to ambient temperature of 40 degrees C. Bearings shall be AFBMA Types BC or RN, heavy duty, or shall otherwise be shown to be suitable for the intended application in terms of B-10 rating life, Class M3 or better.
2. All grease lubricated bearings, except those specified to be factory sealed and lubricated, shall be fitted with an easily accessible grease supply, flush, drain and relief fittings including an externally visible sight glass to view the oil level. Extension tubes shall be used when necessary. Grease supply fittings shall be standard hydraulic type by the Alemite Division of the Stewart-Warner Corporation.
3. Grease lubricated bearings shall be designed for electric motor use. The grease shall be capable of higher temperatures associated with electric motors and shall be compatible with Polyurea-based greases.
4. Bearings shall be rated for a minimum of 26,280 hours L-10 life at full-load direct-coupled, except vertical high thrust motors.
5. Vertical motors shall be capable of withstanding a momentary up-thrust of at least 30% of normal down-thrust.

C. Insulation

1. Insulation systems shall be Class B (130 degrees C) and shall be manufacturer's premium grade, resistant to attack by moisture, acids, alkalis and mechanical or thermal shock. Maximum temperature rise by resistance at rated HP shall not exceed Class B limits (80 degree C)
2. For motors at 1.15 Service Factor, the maximum temperature rise by resistance shall not exceed Class F limits of 115 degree C.
3. Motors for severe duty service shall have vacuum/pressure impregnated epoxy insulation for moisture resistance.
4. Insulation for inverter duty motor windings shall meet or exceed the Pulse Endurance Index for magnetic wire and shall not be injured when exposed to repeated pulse type waveforms, repetitive high voltage transients, switching frequency and rate of rise of the pulse. Class H varnish shall be used.

D. Vibration

1. Vibration shall not exceed 0.15 inch per second, unfiltered peak.

E. Grounding Motor Shafts

1. All motors operated by variable frequency drives shall be provided with shaft grounding attachment devices.
 2. The shaft grounding device shall be a metallic impregnated brush installed onto the shaft rotor such that the brush contacts the rotor surface to ground out any voltage present on the shaft rotor.
 3. Brush shall be bristle type and be easily removable for replacement and maintenance without having to disassemble the motor and remove the rotor.
 4. Shaft grounding device shall be manufactured by Sohre, Aegis or Equal.
- F. Motor Efficiencies (Three Phase Motors)
1. Motor efficiencies shall meet the requirements of the Energy Independence and Security Act (EISA) and be manufactured to meet the following efficiency standards:
 - a. General purpose motors (subtype I) with a power rating of 1 Hp through 200 Hp shall have a nominal full-load efficiency that is not less than as defined in NEMA MG- 1 (2006) Table 12-12 (“NEMA Premium®”) efficiency levels. Subtype I motors include:
 - 1) Foot-mounted 3-digit frame sizes with C-face and foot mount
 - 2) Includes ODP, TEFC, TENV, explosion-proof, etc.
 - b. General purpose motor (subtype II), with a power rating of 1Hp through 200 Hp shall have a nominal full-load efficiency that is not less than as defined in NEMA MG-1 (2006) Table 12-11 (“Energy Efficient ®”) efficiency levels. Subtype II motors include:
 - 1) U-Frame motor
 - 2) Design C motor
 - 3) Close-coupled pump motor
 - 4) Footless motor
 - 5) Vertical solid-shaft normal thrust motor (tested in a horizontal configuration)
 - 6) 8-pole motor (900 rpm)
 - 7) Poly-phase motor with voltage of no more than 600 volts (other than 230 or 460 volts)
 - c. Fire pump motors shall have nominal full-load efficiency no less than as defined in NEMA MG-1 (2006) Table 12-11.
 - d. NEMA Design B, general purpose electric motor, with a power rating of 200 Hp through 500 Hp shall have a nominal full-load efficiency that is not less than as defined in NEMA MG-1 (2006) Table 12-11.
 2. Efficiency values shall be based on tests performed in accordance with IEEE 112, Method B. Motors with horsepower or rpm's not listed shall conform to comparable standards of construction and materials as those for listed motors.
 3. Where California laws dictate higher efficiencies than those listed, the higher efficiency motors shall be furnished.
- G. Motor Power Factor Correction Capacitors
1. All single speed motors with across the line starting over 10 horsepower (i.e., excluding motors powered from variable frequency drives or reduced voltage

starters) shall be provided with a UL listed, heavy duty industrial type power factor correction capacitor mounted at the motor.

2. Power factor correction capacitors shall be as recommended, selected, and furnished by the motor manufacturer to raise the motor power factor to approximately 95 percent.
3. For non-explosion-proof motors, the capacitor shall be mounted on the equipment base plate adjacent to the motor and shall be connected to the motor junction box with liquid tight flexible conduit. For explosion-proof motors, the capacitors shall be wall mounted in a non-hazardous area.
4. Capacitors shall be dry film or liquid insulated and shall be hermetically sealed in steel enclosures.
5. Each capacitor unit shall be furnished with three high interrupting capacity current limiting fuses. Fuses shall be equipped with "blown-fuse" indicators.
6. Capacitor enclosures shall be suitable for conduit connection. Covers shall be gasketed, bolt-on type.
7. Capacitors shall be UL listed.
8. Capacitors shall be by General Electric Co. (ABB); Square D Co. or equal.

**Table 12-11
NEMA Full-Load Efficiencies of Energy Efficient Motors¹
OPEN MOTORS**

Hp	2 POLE		4 POLE		6 POLE		8 POLE	
	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency
1.0	--	--	82.5	80.0	80.0	77.0	74.0	70.0
1.5	82.5	80.0	84.0	81.5	84.0	81.5	75.5	72.0
2.0	84.0	81.5	84.0	81.5	85.5	82.5	85.5	82.5
3.0	84.0	81.5	86.5	84.0	86.5	84.0	86.5	84.0
5.0	85.5	82.5	87.5	85.5	87.5	85.5	87.5	85.5
7.5	87.5	85.5	88.5	86.5	88.5	86.5	88.5	86.5
10	88.5	86.5	89.5	87.5	90.2	88.5	89.5	87.5
15	89.5	87.5	91.0	89.5	90.2	88.5	89.5	87.5
20	90.2	88.5	91.0	89.5	91.0	89.5	90.2	88.5
25	91.0	89.5	91.7	90.2	91.7	90.2	90.2	88.5
30	91.0	89.5	92.4	91.0	92.4	91.0	91.0	89.5
40	91.7	90.2	93.0	91.7	93.0	91.7	91.0	89.5
50	92.4	91.0	93.0	91.7	93.0	91.7	91.7	90.2
60	93.0	91.7	93.6	92.4	93.6	92.4	92.4	91.0
75	93.0	91.7	94.1	93.0	93.6	92.4	93.6	92.4
100	93.0	91.7	94.1	93.0	94.1	93.0	93.6	92.4
125	93.6	92.4	94.5	93.6	94.1	93.0	93.6	92.4
150	93.6	92.4	95.0	94.1	94.5	93.6	93.6	92.4
200	94.5	93.6	95.0	94.1	94.5	93.6	93.6	92.4
250	94.5	93.6	95.4	94.5	95.4	94.5	94.5	93.6
300	95.0	94.1	95.4	94.5	95.4	94.5	--	--
350	95.0	94.1	95.4	94.5	95.4	94.5	--	--
400	95.4	94.5	95.4	94.5	--	--	--	--
450	95.8	95.0	95.8	95.0	--	--	--	--
500	95.8	95.0	95.8	95.0	--	--	--	--

Notes:

- Values included in the table above were taken from the NEMA Standards MG 1-2006**

**Table 12-11
NEMA Full-Load Efficiencies of Energy Efficient Motors¹
ENCLOSED MOTORS**

Hp	2 POLE		4 POLE		6 POLE		8 POLE	
	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency
1.0	75.5	72.0	82.5	80.0	80.0	77.0	74.0	70.0
1.5	82.5	80.0	84.0	81.5	85.5	82.5	77.0	74.0
2.0	84.0	81.5	84.0	81.5	86.5	84.0	82.5	80.0
3.0	85.5	82.5	87.5	85.5	87.5	85.5	84.0	81.5
5.0	87.5	85.5	87.5	85.5	87.5	85.5	85.5	82.5
7.5	88.5	86.5	89.5	87.5	89.5	87.5	85.5	82.5
10	89.5	87.5	89.5	87.5	89.5	87.5	88.5	86.5
15	90.2	88.5	91.0	89.5	90.2	88.5	88.5	86.5
20	90.2	88.5	91.0	89.5	90.2	88.5	89.5	87.5
25	91.0	89.5	92.4	91.0	91.7	90.2	89.5	87.5
30	91.0	89.5	92.4	91.0	91.7	90.2	91.0	89.5
40	91.7	90.2	93.0	91.7	93.0	91.7	91.0	89.5
50	92.4	91.0	93.0	91.7	93.0	91.7	91.7	90.2
60	93.0	91.7	93.6	92.4	93.6	92.4	91.7	90.2
75	93.0	91.7	94.1	93.0	93.6	92.4	93.0	91.7
100	93.6	92.4	94.5	93.6	94.1	93.0	93.0	91.7
125	94.5	93.6	94.5	93.6	94.1	93.0	93.6	92.4
150	94.5	93.6	95.0	94.1	95.0	94.1	93.6	92.4
200	95.0	94.1	95.0	94.1	95.0	94.1	94.1	93.0
250	95.4	94.5	95.0	94.1	95.0	94.1	94.5	93.6
300	95.4	94.5	94.5	94.5	95.0	94.1	--	--
350	95.4	94.5	95.4	94.5	95.0	94.1	--	--
400	95.4	94.5	95.4	94.5	--	--	--	--
450	95.4	94.5	95.4	94.5	--	--	--	--
500	95.4	94.5	95.8	95.0	--	--	--	--

Notes:

1. Values included in the table above were taken from the NEMA Standards MG 1-2006

**Table 12-12
NEMA Premium Full Load Efficiencies¹
OPEN MOTORS**

Hp	3600 RPM		1800 RPM		1200 RPM	
	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency
1.0	77.0	74.0	85.5	82.5	82.5	80.0
1.5	84.0	81.5	86.5	84.0	86.5	84.0
2.0	85.5	82.5	86.5	84.0	87.5	85.5
3.0	85.5	82.5	89.5	87.5	88.5	86.5
5.0	86.5	84.0	89.5	87.5	89.5	85.7
7.5	88.5	86.5	91.0	89.5	90.2	88.5
10	89.5	87.5	91.7	90.2	91.7	90.2
15	90.2	88.5	93.0	91.7	91.7	90.2
20	91.0	89.5	93.0	91.7	92.4	91.0
25	91.7	90.2	93.6	92.4	93.0	91.7
30	91.7	90.2	94.1	93.0	93.6	92.4
40	92.4	91.0	94.1	93.0	94.1	93.0
50	93.0	91.7	94.5	93.6	94.1	93.0
60	93.6	92.4	95.0	94.1	94.5	93.6
75	93.6	92.4	95.0	94.1	94.5	93.6
100	93.6	92.4	95.4	94.5	95.0	94.1
125	94.1	93.0	95.4	94.5	95.0	94.1
150	94.1	93.0	95.8	95.0	95.4	94.5
200	95.0	94.1	95.8	95.0	95.4	94.5
250	95.0	94.1	95.8	95.0	95.4	94.5
300	95.4	94.5	95.8	95.0	95.4	94.5
350	95.4	94.5	95.8	95.0	95.4	94.5
400	95.8	95.0	96.2	95.4	96.2	95.4
450	95.8	95.0	96.2	95.4	96.2	95.4
500	95.8	95.0	96.2	95.4	96.2	95.4

Notes

1. Values included in the table above were taken from the NEMA Standards MG 1-2006.

**Table 12-12
NEMA Premium Full Load Efficiencies¹
ENCLOSED MOTORS**

Hp	3600 RPM		1800 RPM		1200 RPM	
	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency
1.0	77.0	74.0	85.5	82.5	82.5	80.0
1.5	84.0	81.5	86.5	84.0	87.5	85.5
2.0	85.5	82.5	86.5	84.0	88.5	86.5
3.0	86.5	84.0	89.5	87.5	89.5	87.5
5.0	88.5	86.5	89.5	87.5	89.5	87.5
7.5	89.5	87.5	91.7	90.2	91.0	89.5
10	90.2	88.5	91.7	90.2	91.0	89.5
15	91.0	89.5	92.4	91.0	91.7	90.2
20	91.0	89.5	93.0	91.7	91.7	90.2
25	91.7	90.2	93.6	92.4	93.0	91.7
30	91.7	90.2	93.6	92.4	93.0	91.7
40	92.4	91.0	94.1	93.0	94.1	93.0
50	93.0	91.7	94.5	93.6	94.1	93.0
60	93.6	92.4	95.0	94.1	94.5	93.6
75	93.6	92.4	95.4	94.5	94.5	93.6
100	94.1	93.0	95.4	94.5	95.0	94.1
125	95.0	94.1	95.4	94.5	95.0	94.1
150	95.0	94.1	95.8	95.0	95.8	95.0
200	95.4	94.5	96.2	95.4	95.8	95.0
250	95.8	95.0	96.2	95.4	95.8	95.0
300	95.8	95.0	96.2	95.4	95.8	95.0
350	95.8	95.0	96.2	95.4	95.8	95.0
400	95.8	95.0	96.2	95.4	95.8	95.0
450	95.8	95.0	96.2	95.4	95.8	95.0
500	95.8	95.0	96.2	95.4	95.8	95.0

Notes

1. Values included in the table above were taken from the NEMA Standards MG 1-2006.

PART 3 - EXECUTION

3.01 GENERAL

- A. Install all motors in accordance with the manufacturer's printed recommendations and as required under the specific specification sections for the driven equipment.

3.02 INSTALLATION

- A. Motors shall be stored indoors in a clean, dry location with space heaters energized to preclude moisture buildup.
- B. Bolt the motor to the equipment or rigid foundation using bolts of the largest size permitted by the holes in the motor bracket. Do not install motors in such a way as to restrict motor ventilation.
- C. Motor enclosure type shall be used in the following locations unless otherwise specified in the technical specifications:
 - 1. ODP: Non-hazardous, relatively clean, dry, well ventilated area, indoors.
 - 2. WPI: Indoor/Outdoor, relatively clean area, minimal rain and snow.
 - 3. WPII: Indoor/Outdoor, severe rain and snow, dirty environment.
 - 4. TEFC: Indoor/Outdoor, wet, dirty or dusty environment.
 - 5. TENV: Indoor/Outdoor, wet, dirty or dusty environment with well ventilated area and usually cooler temperatures.
 - 6. TEWAC: Indoor/Outdoor, dirty environment, typically used for larger motors sized 250 hp and up.

3.03 FIELD QUALITY CONTROL

- A. Submit field test procedures for the Construction Manager's approval before testing begins. Test and submit test results for each motor.
- B. Field tests and inspections: Field testing shall be as specified in Section 26 05 00.

END OF SECTION

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SECTION 26 08 00

COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Test systems and equipment furnished under Division 26 and repair or replace all defective work and equipment. All new, modified, and existing protective devices shall be tested and adjusted per the requirements of this Contract Documents.
- B. [Employ the services of an independent recognized power systems testing company to perform the tests specified in this Section. Independent testing entity shall be as specified herein and shall not be a manufacturer of any of the electrical equipment provided under other Sections of Division 26 and shall not be the Electrical Subcontractor.]
- C. [Employ the services of the equipment manufacturer responsible for providing the major electrical components and systems as specified in Section [insert appropriate Section number for switchgear, motor control center, generator, or other electrical components] to perform the tests specified in this Section.]
- D. [The electrical subcontractor shall perform the tests specified in this Section.]
- E. Field testing and commissioning shall be performed in accordance with the latest revisions of the following NETA Standards unless otherwise modified by this Section:
- F. ATS "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems"
- G. Submit field test reports for each component tested for the project record files. Test report forms shall be in compliance with NETA standards.
- H. It is the intent of the specified tests to assure that all electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications. Tests shall help determine suitability for energization.
- I. Provide all material, equipment, labor, and technical supervision to perform electrical acceptance testing.
- J. Adjust all protective devices to the settings recommended in the short circuit coordination study, arc flash study, and other analyses per Section 26 05 73.
- K. The term "major electrical equipment" when used in this Section shall include all equipment operating above 480V and other equipment specified in this Section, including but not limited to:
 - 1. New Motor Control Centers
 - 2. New and existing motors and drives.
 - 3. Distribution dry-type transformers and lighting panels

4. Other equipment as necessary to comply with the coordination and arc flash requirements as specified in these Specifications and as per applicable standards and industry recommended practices.
- L. Additional electrical distribution equipment testing is specified under the technical equipment specification Sections of Division 26.

1.02 RELATED SECTIONS

1. Section 26 05 00 – Common Work Results For Electrical
2. Section 26 05 73 – Electrical System Analyses
3. Additional electrical distribution equipment testing is specified under the technical equipment specification sections of Division 26.

1.03 SUBMITTALS

- A. All submittals shall be in accordance with Sections 01 33 00 and 26 05 00.
- B. Submit Electrical Equipment Testing Plan a minimum of four (4) weeks after award of contract. Submittal shall include the following at a minimum:
1. Schedule of Electrical Commission Field Testing prepared using Microsoft Project, including:
 - a. Dates of submittal and Engineer review of all electrical analytical study reports.
 - b. Projected delivery and installation dates of major electrical equipment to the site
 - c. Testing dates for each piece of major electrical equipment and for each type of test specified
 - d. Startup and commissioning date for each major piece of electrical equipment
 2. Commission and field-testing procedure narratives describing the sequence, type, and method of all tests.
 3. Proposed testing forms and signoff sheets to be used for all electrical equipment where testing is required.
- C. Submit commission and field test reports for each testing cycle containing each component tested. Reports shall include:
1. Cover sheet with technician names performing the tests. Dates of the testing shall be included.
 2. Table of Contents organized by equipment type and tag name.
 3. Summary page explaining the purpose of the test, description of equipment, equipment identification tag matching the convention shown on the Drawings, technical specification reference of the equipment, and the specific testing requirement met by the test report. Individual equipment cross reference describing the equipment, location of the component and a report page sheet number on which the technical information is presented.

4. Test data sheets with each piece of equipment or component on a dedicated, unique sheet; page number; the name of the component under test, the major piece of equipment in which the component is located..
 5. Opinion whether or not the equipment being tested complies with the specification. Any discrepancies shall be noted in the concluding summary of the report. Test report forms shall be in compliance with NETA standards.
- D. Incorporate testing results as part of the O&M Manuals per Section 01 78 23 and as required per NFPA 70E for Arc Flash Labeling documentation.

1.04 REFERENCE STANDARDS

- A. Testing required under this Section shall be per the guidelines specified in the NETA publication "Acceptance Testing Specification for Electric Power Distribution Equipment and Systems." Testing requirements in this Section are specifically referenced to the edition of this publication issued at time of bid opening.
- B. All inspections and tests shall be in accordance with the following codes and standards except as provided otherwise Specifications. Where reference is made to one of the standards, the revision in effect at the time of bid opening shall apply.
1. InterNational Electrical Testing Association
 - a. NETA ATS – Acceptance Testing Specifications (latest edition)
 2. American National Standards Institute
 - a. ANSI C2 – National Electrical Safety Code
 3. National Fire Protection Association - NFPA
 - a. ANSI/NFPA 70: National Electrical Code
 - b. ANSI/NFPA 70B: Electrical Equipment Maintenance
 - c. NFPA 70E: Standard for Electrical Safety in the Workplace
 - d. ANSI/NFPA 101: Life Safety Code
 4. Occupational Safety and Health Administration - OSHA
 - a. OSHA 29-CFR, Part 1910 Subpart S - Electrical
 5. Other applicable State and local codes and ordinances

1.05 QUALIFICATIONS

A. Testing Firm Qualifications:

1. The Testing Firm shall have been continuously engaged in the testing of the type of electrical equipment furnished on this Project for a minimum of ten years.
2. The Testing Firm shall meet federal OSHA criteria for accreditation of testing laboratories, Title 29, Parts 1907, 1910, and 1936. Full membership in the International Electrical Testing Association constitutes proof of such criteria.
3. Testing Firm shall utilize only full-time technicians who are regularly employed and NETA certified. Technicians performing testing on this Project shall be supervised by a NETA ETT Senior Certified Level IV. Electrically unskilled employees are not permitted to perform testing or assistance of any kind. Electricians and/or linemen may assist but may not perform testing and/or inspection services.

4. All instruments used by the Testing Firm to evaluate electrical performance shall meet NETA's Specifications for Test Instruments.
5. The testing firm shall have a designation of "NETA Accredited Company" issued by the InterNational Electrical Testing Association.
6. The testing firm shall submit appropriate documentation to demonstrate that it satisfactorily complies with these requirements.

1.06 FINAL SYSTEM DOCUMENTATION

- A. Incorporate final versions of electrical test reports into the project operations and maintenance manuals as specified under Section 26 05 00.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL TESTING PROCEDURES

- A. The testing instruments shall be maintained in calibration per the requirements of NETA.
- B. The test reports shall be in accordance with NETA except that reports shall be completed no later than 30 days after completion of testing on each piece of equipment.
- C. Safety procedures as documented in CAL OSHA, NETA, and other applicable industry safety standards shall be adhered to.

3.02 FIELD TEST EQUIPMENT

- A. All test equipment shall be in good mechanical and electrical condition.
- B. Selection of metering equipment should be based on the waveform of the variable being measured. Digital multimeters shall be RMS sensing type unless another type is required to accurately measure the variable under test.
- C. Field test metering used to check power system meter calibration must have accuracy higher than that of the instrument being checked.
- D. Accuracy of metering in test equipment shall be appropriate for the test being performed.
- E. Waveshape and frequency of test equipment output waveforms shall be appropriate for the test and tested equipment.
- F. Test Instrument Standards
 1. All equipment used for testing and calibration procedures shall exhibit the following characteristics:
 - a. Maintained in good visual and mechanical condition.
 - b. Maintained in safe operating condition.
 - c. Portable multimeters shall be true RMS measuring.

- d. Test equipment should have operating accuracy equal to, or better than, the accuracy as recommended by NETA standards.

G. Test Instrument Calibration

1. The Contractor shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.
2. The accuracy shall be directly traceable to the National Institute of Standards and Technology.
3. Instruments shall be calibrated in accordance with the following frequency schedule:
 - a. Field instruments: 12 months maximum.
 - b. Leased specialty equipment: 12 months.
 - c. Dated calibration labels shall be visible on all test equipment.
 - d. Records, which show date and results of instruments calibrated or tested, must be kept up-to-date.
 - e. Up-to-date instrument calibration instructions and procedures shall be maintained for each test instrument.
 - f. Calibrating standard shall be of higher accuracy than that of the instrument tested.

3.03 COMMISSION AND FIELD TESTING APPROACH AND DOCUMENTATION

A. General Requirements

1. Testing and commissioning shall be performed in accordance with the latest revision of NETA Standard ATS "Acceptance Testing Specifications" for Electrical Power Distribution Equipment and Systems.
2. Testing shall be performed in two separate and totally independent steps.
3. Test reports:
 - a. A typed report shall be submitted after each testing step is completed. The report shall be submitted to the Engineer for review, comment and record purposes.
 - b. The report shall include a separate data sheet for each component (i.e. cable, circuit breaker, transformer, relay, etc.) tested. Each data sheet shall include the weather conditions at the time of the test (i.e. temperature, humidity, sunny, rain, etc), the tester's observation and findings, discrepancies, any remedial work performed or act to resolve problems, technical parameters obtained during the tests, as left settings of all devices, and a statement indicating the equipment is ready to be energized.
 - c. The report shall be organized in a three-ring binder and provided with a table of contents and index.
 - d. The report shall contain a statement indicating the equipment was tested in accordance with the procedures outlined in the latest edition of The International Testing Association Acceptance Testing Specifications.

- B. Test sequence summary: The following describes the testing steps to be performed:
1. Step No. 1 – Contractor’s Preliminary Test: Before the electrical equipment is energized, the Contractor shall test the equipment and set all protective relays, timers, etc., in accordance with the approved Short Circuit and Coordination Study and Arc Flash Hazard Study.
 2. Step No. 2 – Manufacturer’s Testing and Installation Certification
 3. Step No. 3 – Commissioning testing
- C. The Engineer shall be notified in writing immediately of any and all components that have unsatisfactory test results. The notification shall be accompanied with a proposed remedy, remedy schedule, and impact to the project schedule.
- D. Step No. 1 – Contractor’s Preliminary Tests: Testing requirements to be performed by the Contractor before the equipment is energized:
1. Inspect and mechanically operate all air interrupter switches, circuit breakers, power disconnect switches, switches supplied on transformers, and circuit breakers/disconnect switches installed within equipment furnished under other divisions of these specifications.
 2. Set, calibrate and test all protective devices including but not limited to, circuit breakers, protective relays, timing devices, motor overload, electrical protective devices located with equipment furnished under other Sections of these specifications.
 3. Verify that protective relay, current transformers, ground sensing devices, transformer grounding resistors, fuses, interrupter switches, transfer switches, transformers and motor starters furnished are in accordance with the approved shop drawings and the Short Circuit and Coordination Study and Arc Flash Hazard Study.
 4. Megger test all low voltage power system cables.
 5. Test transformer insulating oil, check connections and proper torque and tightness of cables and bushings and perform high potential testing.
 6. Verify that all power and control power fuses installed are in accordance with the manufacturer’s approved shop drawings, the Short Circuit and Coordination Study and the NEC. Replace fuses found to be of the incorrect rating.
 7. Verify control circuits and functionality of the controls for all motors, automatic transfer systems, remote protective device (i.e. wiring for differential protection relays, alarm systems, safety interlocks, emergency stop controls, and motor, transformer and generator protective devices). The functionality shall be in accordance with the approved control schematics, wiring diagrams or functional descriptions.
 8. Check motor nameplates for correct phase and voltage; verify motor phase rotation.
 9. Verify the resistance to ground of all power distribution equipment is 5 ohms or less.
 10. Verify all terminations at the main switchboard, motors, and VFDs, are correctly made and properly torqued.
 11. Refer to the individual equipment and material specification sections for additional testing requirements.

12. Verify all circuit breaker ratings and settings are as required by the Contract Documents or as amended during shop drawing review. Advise the Engineer of discrepancies and make changes as directed by the Construction Manager.
 13. Verify proper operation of accessories, devices and motor interlocks.
 14. Submit comprehensive test report.
- E. Step No. 2 – Manufacturer’s Testing and Installation Certification
1. Where called for in the individual equipment technical specifications provide the services of a certified manufacturer’s technician to test the installed equipment and submit certification that the installed equipment meets the manufacturer’s requirements.
- F. Step No. 3 – Employ the service of a third-party electrical power systems testing company (the Testing Firm) to perform a final acceptance test of the completed electrical systems. “Third Party” shall mean a testing firm that is not affiliated with the Contractor or Electrical Subcontractor.
1. The Testing Firm shall obtain the test reports for testing previously submitted along with the approved/corrected Short Circuit and Coordination Study and Arc Flash Hazard Study per Section 26 05 73 and become familiar with the approach, conclusions, and recommendations. All potential discrepancies in the analytical studies shall be addressed by the Testing Firm before the testing begins.
 2. Test all new and modified equipment, components, controls, systems, and hardware provided under this Contract.
 3. Testing shall follow the specific NETA ATS procedures, including “optional” items, for the equipment being tested.
 - a. Testing shall follow all NETA procedures for the particular equipment or systems being tested.
 - b. Standard NETA test forms or equivalent shall be utilized in conformance with the favorably reviewed test plan.
 - c. All visual and mechanical inspections and electrical tests shall be performed in accordance with the latest edition of the NETA requirements.
 - d. Perform inspections and testing for all the equipment in conformance with NETA guidelines including all inspections and testing requirements listed as “optional”.
 - e. The NETA requirements for visual and mechanical inspections of equipment are considered the Contractor's responsibility under this Work. At the Contractor's discretion, however, the work may be included under this Section.

END OF SECTION

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SECTION 26 22 13

LOW-VOLTAGE DRY TYPE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work included

1. Distribution transformers shall be provided where shown on the Drawings, single-phase or three-phase and with rated kVA.

1.02 RELATED WORK

1. Section 26 05 00 – Common Work Results For Electrical
2. Section 26 08 00 – Electrical System Analyses and Acceptance Testing

1.03 SUBMITTALS

A. Submittals shall be made in accordance with Section 01 33 00 and Section 26 05 00.

B. Submit the following for review:

1. Manufactures literature including equipment data sheets.
2. Plan, front, and side view drawing including overall dimensions, weights, and anchoring details
3. Load center schedules for each load center showing circuit allocations, breaker rating, spare, short circuit and bus ratings
4. Equipment seismic qualifications and anchorage details; provide seismic calculations for units greater than 400lbs conforming to Section 01 61 20 as appropriate
5. Mounting bracket design for wall-mount applications
6. Installation and O&M manuals
7. Certified factory test reports

C. Submit data indicating basis of determining phase shift angles and kVA rating for harmonic mitigation transformers conforming to the harmonic mitigation analysis per Section 26 05 73.

1.04 REFERENCES

A. American National Standards Institute

1. ANSI Z55.1: Gray Finishes For Industrial Apparatus and Equipment

B. Department of Energy

1. DOE 10 CFR 429 – Certification, compliance, and Enforcement for Consumer Product and Commercial and Industrial Equipment

2. DOE 10 CFR Part 431 – Energy Efficiency Program for Certain Commercial and Industrial Equipment
- C. Institute of Electrical and Electronics Engineers (IEEE)
 1. IEEE C57.12.01: Standard General Requirements for Dry-Type Distribution and Power Transformer
 2. IEEE C57.110: Recommended Practice for Establishing Transformer Capability When Supplying Non Sinusoidal Load Currents
- D. National Electrical Manufacturers Association (NEMA).
 1. TP-1: Guide for Determining Energy Efficiency for Distribution Transformers.
- E. Underwriters Laboratories (UL)
 1. UL 1561: Standard for Dry-Type General Purpose and Power Transformers
- F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Provide transformers as manufactured by:
 1. Eaton Corporation/Cutler-Hammer
 2. General Electric (ABB)
 3. Square D
 4. Approved equal

2.02 DISTRIBUTION TRANSFORMERS

- A. General
 1. Transformers shall be designed, manufactured and tested in accordance with applicable ANSI, NEMA and IEEE standards and shall be UL listed.
 2. Transformer shall be DOE 10 CFR 429 and DOE 10 CFR part 431 compliant, energy efficient for kVA rating 15kVA and higher.
 3. Transformer shall be of the two winding, self cooled type with kVA ratings as indicated on the drawings.
 4. Insulation system shall be a 220°C (Class R) winding insulation system with [80, 115, 150°C] rise and be capable of 15% continuous overload. Performance shall be based on 40°C ambient.
 5. Coils shall be wound of electrical grade copper and be continuous wound construction. BIL (Basic Impulse Level) shall be 10kV.
 6. Enclosure shall be made of heavy gauge steel and with ANSI 61 coating color and shall be UL recognized for outdoor use. Enclosure construction shall be ventilated, NEMA 2, drip proof. For outdoor use provide a weather shield.

7. The transformer shall include a wiring compartment for conduit entry. The maximum temperature on top of the transformer shall not exceed 90°C.
8. Sound level shall not exceed the NEMA ST-20 maximum average sound level for dry type transformers.
9. Provide K-rated transformer where indicated on the drawings. K-rated transformers shall have 200% rated neutral of normal phase current and be UL listed suitable for non-sinusoidal current loads. [Minimum] K rating shall be [4][13][20][as shown on the Drawings].
10. Primary and secondary voltage, phase, and kilovolt-ampere shall be as indicated on the Drawings. Provide four full capacity taps, two for 2-1/2 percent above and two for 2-1/2 percent below rated primary voltage.

2.03 UNITIZED POWER CENTERS

A. General

1. Where shown on the Drawings, provide integrated unitized load centers comprised of a primary main circuit breaker, encapsulated dry-type transformer, and a load center panelboard with a secondary main circuit breaker. Unitized load center components shall be integrated into a common enclosure.

B. Rating

1. Unitized load center kVA and voltage ratings shall be as shown on the Drawings.
2. Load centers shall be fully rated for the specified fault current interrupting capacity. Series connected short circuit ratings will not be acceptable.
3. Provide load centers including a primary main breaker/disconnect and be UL Listed for service entrance applications where required.
4. Transformer noise level shall not exceed the following values when measured in accordance with NEMA ST20:
 - a. 1-9 kVA – 40 dBA
 - b. 10-50 kVA – 45 dBA

C. Construction

1. Transformer shall have copper windings. Transformer core and coil shall be completely resin encapsulated and shall have a minimum 180° C insulation with 115° C rise. Provide Class H insulation.
2. All interiors shall be completely factory assembled with circuit breakers, wire connectors, etc. All wire connectors, except screw terminals, shall be of the anti-turn solderless type and all shall be suitable for copper or aluminum wire of the sizes indicated.
3. Provide unitized load centers allowing circuit breaker replacement without disturbing adjacent units, without removing the main bus connectors, and without machining, drilling or tapping.
4. Branch circuits shall be arranged using double row construction except when narrow column panels are indicated. Branch circuits shall be numbered by the manufacturer.
5. A nameplate shall be provided listing manufacturer's name, panel type and rating.
6. Construction of panel shall be door-in-door type.

D. Buses

1. Bus bars for the mains shall be of copper. Full size neutral bars shall be included. Phase bussing shall be full height without reduction. Cross connectors shall be copper.
2. Neutral bussing shall have dedicated lugs for each outgoing feeder circuit requiring a neutral connection.
3. Spaces for future circuit breakers shall be bussed for the maximum device that can be fit into them.
4. Provide manufacturer's integral equipment grounding terminal bar for all grounding and bonding conductor connections as required under Article 450. Field retrofit of ground bus bars for neutral grounding shall not be acceptable.

E. Boxes

1. Surface mounted boxes and trims shall have an internal and external finish as hereinafter specified below. Surface mounted boxes shall be field punched for conduit entrances.
2. Provide at least 4 studs for mounting the load center interior.

F. Trim

1. Hinged doors covering all circuit breaker handles shall be included in all panel trims.
2. Doors shall have semi flush type cylinder lock and catch, except that doors over 48-in in height shall have a vault handle and 3-point catch, complete with lock, arranged to fasten door at top, bottom and center. Door hinges shall be concealed. Furnish two keys for each lock. All locks shall be keyed alike; directory frame and card having a transparent cover shall be furnished on each door.
3. Trim shall be fabricated from code gauge sheet steel.
4. All exterior and interior steel surfaces of the load center shall be properly cleaned and finished with ANSI Z55.1, No. 61 light gray paint over a rust-inhibiting phosphatized coating. The finish paint shall be of a type to which field applied paint will adhere.
5. Trim for flush panels shall overlap the box by at least 3/4-in all around. Surface trims shall have the same width and height as the box. Trims shall be fastened with quarter turn clamps.

G. Components

1. Load centers shall be equipped with circuit breakers with frame size and trip settings as shown on the Drawings.
2. Circuit breakers shall be molded case, bolt-in type. Handle ties are not acceptable for multi-pole breakers.
3. Secondary circuit breakers shall have an interrupting capacity of not less than 10,000 amperes RMS symmetrical.
4. Circuit breakers shall be as manufactured by the unitized load center manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install assembly on concrete housekeeping pad or wall mounted support system as shown on the on the Drawings. Provide vibration-absorbing pads and securely anchor the unit to the base or wall to minimize sound transmission.
- B. Transformer shall be properly anchored in accordance with the approved anchoring calculations conforming to the seismic requirements as specified in Section 01 61 20.
- C. Make final conduit connections using suitable flexible conduit as specified in Section 26 05 33 for equipment subject to vibration and for reducing noise transmission through the conduit system.
- D. Transformer neutral grounding shall be sized as shown on the Drawings. Make connections to the facility ground grid as shown on the Drawings and conforming to the NEC for separately derived systems. Provide transformer ground bar
- E. Maintain a maximum 12" and a minimum of 6" separation from building structure for heat dissipation.
- F. Provide permanent nameplate on the transformer indicating location of the disconnecting means if remotely mounted from the unit.

3.02 FACTORY TESTS

- A. Transformer shall be tested in accordance with IEEE C57.12.01:
 - 1. Resistance measurements of all windings on the rated voltage connections and on all tap connections of each transformer
 - 2. Ratio tests on the rated voltage connections and on all tap connections
 - 3. Phase relation and polarity tests on the rated voltage connection
 - 4. No-load losses and excitation current at rated voltage on the rated voltage connections
 - 5. Impedance and load losses at rated current and rated frequency on the rated voltage connections of each transformer
 - 6. Potential tests
 - 7. Regulation and Efficiency at rated load and voltage
 - 8. Insulation resistance tests for high voltage to ground, low voltage to ground, and high voltage to low voltage
 - 9. Temperature tests

3.03 FIELD QUALITY CONTROL

- A. Site Tests, Inspections: acceptance testing shall be as specified in Section 26 08 00.
- B. Adjust primary taps so that secondary voltage is within 2 percent of rated voltage.

END OF SECTION

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SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work included.

1. Furnish all labor, materials, equipment and incidentals required and install all lighting and distribution panelboards as shown on the Drawings and as specified herein.

1.02 RELATED SECTIONS

1. Section 26 05 00 – Common Work Results for Electrical.
2. Section 26 05 73 – Electrical System Analyses
3. Section 26 08 00 – Commissioning of Electrical Systems

B. Related work:

1. Panelboard schedules are shown on the Drawings.

1.03 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 26 05 00.

B. The Contractor shall furnish submittals for approval as outlined below:

1. Submit catalog cuts and descriptive literature for each type of panelboard and breaker provided.
2. Submit panelboard directory for each panelboard showing circuit allocations, breaker rating, poles, spare, short circuit, and continuous bus ratings.
3. Submit outline drawings showing panel layouts, dimensions and weights. Panel layout shall show circuit breakers allocation and available space.
4. Submit seismic anchoring and mounting calculations in accordance with Section 01 61 20. As a minimum, the calculations shall demonstrate that each of the panelboards will adequately transfer the design seismic forces to the anchor bolts and foundation.

1.04 REFERENCE STANDARDS

A. American National Standard Institute (ANSI)

1. ANSI Z55.1 - Gray Finishes for Industrial Apparatus and Equipment

B. Institute of Electrical and Electronics Engineers (IEEE)

1. ANSI/IEEE C37.90 – IEEE Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus

2. ANSI/IEEE C62.41 - IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits
 3. ANSI/IEEE C62.45 - IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits
 4. IEEE 693 - IEEE Recommended Practice for Seismic Design of Substations
- C. National Electrical Manufacturers Association (NEMA):
1. PB-1 - Panelboards
- D. National Fire Protection Association (NFPA):
1. NFPA 70 – National Electrical Code (NEC).
- E. Underwriters Laboratories (UL).
1. UL 50 – UL Standard for Enclosures for Electrical Equipment
 2. UL 67 – UL Standard for Panelboards
 3. UL 1449 – UL Standard for Surge Protection Devices
- F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 PROJECT SITE REQUIREMENTS

1. Refer to Section 26 05 00

1.06 QUALIFICATIONS

- A. Seismic compliance shall be qualified only through shake table testing. Compliance by calculation is not acceptable.
- B. Power panelboards shall be qualified for use in seismic areas as follows:
1. High seismic loading as defined in IEEE Std 693-1997, with 2.0 amplification factor.
 2. IBC-2006, $S_d = 1.63g$, $S_s = 240\%$, $I_p = 1.5$, for all z/h greater than 0 and $S_d = 2.0g$, $S_s = 300\%$, $I_p = 1.5$, for z/h equal to 0 in accordance with ICC-ES-AC156.
- C. Lighting panelboards shall be qualified for use in seismic areas as follows:
1. High seismic loading as defined in IEEE Std 693-1997, with 1.3 amplification factor.
 2. IBC-2006, $S_d = 1.0g$, $S_s = 150\%$, $I_p = 1.5$, for all z/h greater than 0 and $S_d = 1.6g$, $S_s = 240\%$, $I_p = 1.5$, for z/h equal to 0 in accordance with ICC-ES-AC156.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Panelboards shall be fully rated for the specified circuit breaker fault current interrupting capacity. Series connected short circuit ratings are not acceptable.

- B. Provide panelboards UL listed as suitable for service entrance equipment where noted on the Drawings or as required by the NEC. Service entrance type UL Label shall be factory installed.
- C. Construction
1. Panelboard construction shall be per the requirements of UL 50 and UL 67.
 2. Provide panelboards with factory assembled interiors complete with bussing, circuit breakers, wire connectors, etc. All wire connectors, except screw terminals, shall be of the anti-turn solderless type, suitable for copper or aluminum wire of the sizes indicated on the Drawings.
 3. Provide interiors designed so that circuit breakers can be replaced without disturbing adjacent units and without removing the main bus connectors. Circuiting changes shall be field executed without machining, drilling or tapping.
 4. Branch circuits shall be arranged using double row construction except when column-type construction is indicated. Branch circuits shall be numbered by the manufacturer.
 5. Provide manufacturer's nameplate listing manufacturer's name, panel type, and ratings. A second identification nameplate shall be provided on the front of each panelboard with the panelboard designation shown on the Drawings. Designation nameplates shall be as specified in Section 26 05 00.
 6. Hinged doors covering all circuit breaker handles shall be included in all panel trims. Doors shall have semi flush type cylinder lock and catch, except that doors over 48-in in height shall have a vault handle and 3-point catch with lock, arranged to fasten door at top, bottom and center. Door hinges shall be concealed. Furnish two keys for each lock. All panelboard locks shall be keyed alike.
 7. Provide directory frame and card having a transparent cover on the door interior.
 8. All exterior and interior steel surfaces of the panelboard shall be properly cleaned and finished with ANSI Z55.1, No. 61 light gray paint over a rust-inhibiting phosphatized coating. The finish paint shall be of a type to which field applied paint will adhere.
 9. Trim for flush panels shall overlap the box by at least 3/4-in all around. Surface trim shall have the same width and height as the box. Trim shall be fastened with quarter turn clamps. Fabricate trim from code gauge sheet steel.
 10. Provide at least 4 studs for mounting the panelboard interior.
- D. Buses
1. Provide copper phase and neutral bus bars. Provide full-height/full-rating phase and neutral bussing without tapering or reduction. Cross connectors shall be copper.
 2. Neutral bussing shall have a suitable lug for each outgoing feeder requiring a neutral connection. Provide 100% [200%] rated neutral bus where shown on the Drawings.
 3. Spaces for future circuit breakers shall be bussed for the maximum number devices for the panelboard as shown on the Drawings.
 4. Provide copper panelboard ground bus.

E. Boxes

1. Panelboard boxes and enclosures shall conform to the NEMA ratings as specified in Section 26 05 00.
2. Recessed or flush mounted boxes shall be made from galvanized code gauge steel with multiple conduit knockouts.
3. Surface mounted boxes and trim shall have an internal and external finish as specified. Surface mounted boxes have blank ends, field punched for conduit entrances.
4. Boxes shall be of sufficient size to provide a minimum wire gutter space of 4-in on all sides.
5. NEMA 12 Panels
 - a. Panels shall be polyester coated steel with continuously welded seams and no holes or knockouts. Covers and doors shall have gaskets and hardware shall be stainless steel.
6. NEMA 3R, 4, and 4X Panels:
 - a. Panels shall be made from [painted steel] [stainless steel with natural finish].
 - b. Panel boxes and covers shall be bolted together and gasketed.
 - c. Panel exterior doors shall be provided with 3 point latches and handle with padlocking provisions.
7. Provide reduced width column-type panelboards where shown on the Drawings including trough extensions and pullbox.

2.02 LIGHTING AND AUXILIARY LOAD PANELBOARDS

- A. Application: Provide lighting and auxiliary load panelboards (generally referred to as Lighting Panels on the Contract Documents) for serving lighting, receptacles, and ancillary project loads operating at less than 250V to ground, single or three-phase.
- B. Ratings:
 1. Voltage rating: as shown on the Drawings.
 2. Continuous bus current rating: as shown on the Drawings.
 3. Minimum short circuit current rating: as shown on the Drawings.
- C. Circuit Breakers
 1. Lighting panelboards shall be equipped with circuit breakers with frame size, number of poles, and trip settings as shown on the Drawings.
 2. Circuit breakers shall be as manufactured by the lighting panelboard manufacturer.
 3. Two and three-pole circuit breakers shall be constructed as a single unit with common handle. The use of single pole breakers with handle-ties, special brackets, other "ganging" means are not acceptable.
 4. Lighting panel main and feeder circuit breakers shall be thermal-magnetic type. Provide bolt-on, heavy-duty breakers with toggle handles or other means to visually indicate when the unit has tripped. Provide circuit breaker interrupting rating matching or exceeding the required rating of the panelboard where installed.

5. GFCI (ground fault circuit interrupter) shall be provided for circuits where shown on the Drawings. GFCI units shall be 1 pole, 120 Volt, or 2 pole, 240 Volt as shown on the Drawings. Provide molded case, bolt-on breakers, incorporating a solid state ground fault interrupter circuit insulated and isolated from the breaker mechanism. The unit shall be UL listed Class A Group I device (5 milliamp sensitivity, 25 millisecond trip time) and a minimum interrupting capacity of 10,000 amperes RMS. GFCI units used for heat tracing or where required by the served equipment manufacturer shall have 30 mA sensitivity.
 6. Provide circuit breaker handle locks for circuits serving critical supervised loads where shown on the Drawings.
- D. Digital Electronic Trip Unit for Molded Case (Main) Circuit Breakers: Provide digital electronic trip units that comply with all of the following:
1. The protective trip unit shall consist of a solid state, microprocessor based programmer; tripping means; current sensors; power supply and other devices as required for proper operation.
 2. Provide true RMS sensing long time and short time protective functions.
 3. Provide electronic display for monitoring settings, trip targets, and the specified metered parameters. Display trip targets for long time, short time, and ground fault, if included; include visual illuminated indication of the trip unit (normal, pickup, trip, error). Provide keypad to provide local setup and readout of all trip settings on the display.
 4. Provide UL Listed interchangeable rating plug. It shall not be necessary to remove the trip unit to change the rating plug.
 5. Trip unit noise immunity shall meet the requirements of IEEE C37.90.
 6. As a minimum, the trip unit shall have the following protective functions:
 - a. Current setting or long time pickup, adjustable from 50% to 100% of the rating plug value.
 - b. Adjustable long time delay with typical inverse time characteristics Instantaneous pickup, adjustable from 2 to 10 times the rating plug.
 - c. Short time pickup and delay. Short time pickup shall be adjustable at least from 1.5 to 9 times the long time pickup setting.
- E. Acceptable Manufactures:
1. General Electric (ABB), A-Series Panelboard
 2. Eaton Corporation/Cutler-Hammer, Pow-R-Line Series Panelboard
 3. Square D
 4. Approved equal

2.03 POWER DISTRIBUTION PANELBOARDS

- A. Application: Provide power distribution panelboards (generally referred to as Distribution Panels on the Contract Documents) for serving lighting, receptacles, and ancillary project loads operating at more than 250V to ground, three-phase.
- B. Ratings:
1. Voltage rating: 277Y/480 V [or as shown on the Drawings]

2. Continuous bus current rating: [400] [600] [800] [1200] Amperes [or as shown on the Drawings]
3. Minimum short circuit current rating: [10][22][65][100] kA Symmetrical [or as shown on the Drawings]
4. Where 100% circuit breakers are specified, provide UL listed circuit breakers rated for 100% of their continuous ampere rating in the panelboard enclosure provided.

C. Circuit Breakers

1. Lighting panelboards shall be equipped with circuit breakers with frame size, number of poles, and trip settings as shown on the Drawings.
2. Circuit breakers shall be as manufactured by the distribution panelboard manufacturer.
3. Two and three-pole circuit breakers shall be constructed as a single unit with common handle. The use of single pole breakers with handle-ties, special brackets, other “ganging” means are not acceptable.
4. Distribution panel main and feeder circuit breakers shall be thermal-magnetic type. Provide bolt-on, heavy-duty breakers with toggle handles or other means to visually indicate when the unit has tripped.
5. GFCI (ground fault circuit interrupter) shall be provided for circuits where shown on the Drawings. GFCI units shall be 1 pole, 277 Volt, molded case, bolt-on breakers, incorporating a solid state ground fault interrupter circuit insulated and isolated from the breaker mechanism. The unit shall be UL listed Class A Group I device (5 milliamp sensitivity, 25 millisecond trip time) and a minimum interrupting capacity of 14,000 amperes RMS rated for 30 mA ground fault protection.

or

6. Main Circuit Breakers: Main circuit breaker shall be molded case, 3 Pole, 600 Volt, [100 percent] [80 percent] rated, fix mount type, manually operated with stored energy closing mechanism. Frame ratings, trip ratings, and interrupting ratings shall be as shown on the Drawing. The breaker shall be General Electric (ABB) Spectra with microEntelliGuard trip device or Eaton Corporation/Cutler Hammer Series C with Digitrip RMS310 trip device, Square D, or equal. Trip device shall be true RMS sensing microprocessor based and include the following:
 - a. Adjustable long time I^2t pickup and delay
 - b. Adjustable short time I^2t pickup and delay
 - c. Adjustable high range instantaneous
 - d. Adjustable ground fault pickup and delay
 - e. Overload, short circuit and ground fault indicator lights
7. Feeder Protective Devices
 - a. Feeder circuit breakers shall be 80% rated molded case 3 pole, 600 volt fixed mount circuit breakers with inverse time-current characteristics unless noted otherwise. [Circuit breakers [larger than 150 amps] shall use digital true RMS sensing trip units and a rating plug to determine the breaker trip rating.] The breakers shall be General Electric (ABB) Spectra; Eaton Corporation/Cutler Hammer Series C breaker; Square D or approved equal.
 - b. Feeder circuit breakers with Ampere frame (AF) sizes greater than [150] [250] A shall be [80%] [100%] rated, molded case, 3 Pole, 600 Volt, fixed

mount type circuit breakers equipped with true RMS sensing microprocessor based trip unit. The breakers shall be General Electric (ABB) Spectra MicroEntelliguard, Eaton Corporation/Cutler Hammer Series C breaker with Digitrip **RMS 310**; Square D, or approved equal. The trip unit shall include the following:

- 1) Adjustable long time pickup and delay
- 2) Adjustable short time pickup and delay
- 3) Adjustable instantaneous

D. Acceptable Manufactures:

1. General Electric (ABB), Spectra Series Panelboard
2. Eaton Corporation/Cutler-Hammer, Pow-R-Line Series Panelboard
3. Square D
4. Approved equal

2.04 SURGE PROTECTION DEVICE (SPD)

- A. The SPD shall be mounted integrally with the panelboard and shall be manufactured by the same manufacture as the panelboard.
- B. The Voltage Protection Rating (VPR) shall be tested in accordance with UL-1449 (third edition). Where an integral disconnect is provided, the VPR shall be determined with the integral disconnect included. The VPR rating shall not exceed the voltage values of the following table.
 1. UL 1449 3rd Edition Voltage Protection Ratings (VPR) with integral disconnect.

SPD Voltage Rating	System Configuration	L-N	N-G	L-G	L-L
120/208-240	WYE (or) Single-Split Phase	900	900	900	1200
277/480	WYE	900	900	900	1200
240	Delta	1500	1500	1500	3000

- C. Surge Life Rating shall be determined as defined by ANSI/IEEE C62.41.2-2002.
- D. Surge Current Ratings shall be as follows:
 1. Distribution Panel Locations
 - a. Maximum Single Impulse Surge Current Rating: [100] **[80]** [65] kA per mode.
 - b. UL 1449 Nominal Discharge Current Rating (In): 20kA
 - c. Minimum Surge Life Rating: 5,000 IEEE C62.41 C-High (C3) impulses
 2. Branch and Lighting Panelboards
 - a. Maximum Single Impulse Surge Current Rating: [100] [80] **[65]** kA per mode.
 - b. UL 1449 Nominal Discharge Current Rating (In): 20kA

- c. Minimum Surge Life Rating: 5,000 IEEE C62.41 C-High (C3) impulses
- 3. The SPD shall have maximum surge current rating based on testing of a complete SPD unit including fuses and all components that make up the SPD system using an IEEE C62.41, 8x20us current wave applied at the maximum, per mode rated value of the SPD. Devices that derive a maximum surge current rating by adding test results of individual components are not acceptable.
- E. Mark the SPD short-circuit current (SCCR) rating on the SPD in accordance with the requirements of UL 1449 and NEC Article 285.
- F. The Maximum Continuous Operating Voltage (MCOV) for all voltage configurations shall be at least 115% of nominal on 480/277 volt systems and 125% of nominal on 240-208/120 volt systems.
- G. Provide SPD fusing system capable of allowing the rated Maximum Single Impulse Surge Current to pass without premature fuse operation. SPDs utilizing a fusing system that opens at or below the Maximum Single Impulse Surge Current rating are not acceptable.
- H. Provide integral fusing for each suppression component. Designs that rely solely on an electrical panel's main breaker to interrupt fault currents resulting from a shorted suppression component are not acceptable.
- I. SPDs installed in distribution panel shall have an integral non-fused disconnect. SPDs installed in lighting panels branch panel locations shall be connected to the main bus with a dedicated branch breaker.
- J. SPDs shall be factory-mounted integral to the electrical distribution equipment and shall not violate the equipment manufacturer's UL label.
- K. Provide status indicator lights, form C status relay for remote monitoring, six-Digit Digital Surge Event Counter with battery backup, and audible alarm with enable/disable switch.
- L. Provide SPD by General Electric (ABB) Tranquell Series, Eaton Corporation/Cutler-Hammer Clipper Power System, Visor Series, Square D, or approved equal.

2.05 PANEL MOUNTED METERING

- A. Metering shall be mounted integrally with the panelboard and shall be manufactured by the same manufacturer as the panelboard.
- B. Meter shall come equipped with a disconnect, shorting block and CTs.
- C. Meter shall be visible through the deadfront of the panelboard.
- D. Provide metering by General Electric (ABB), Eaton Corporation/Cutler-Hammer, Square D, or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Mount and anchor panelboards per the approved seismic anchoring calculations and recommendations where applicable. Where seismic calculations are not required, mount and anchor per manufacturer's recommendations unless noted otherwise.
- B. Mount boxes for surface mounted panelboards so there is at least 1/2-in air space between the box and the wall. Mount panelboard so that height of the operating handle of the topmost mounted device is less than 6'6" (2 meters) above the finished floor or operating surface.
- C. Install panelboards in accordance with manufacturer's recommendations. Connect main and branch feeder circuits on proper terminals. Minimize excess wire within the panelboard enclosure to decrease excess heat generation. Arrange cables in wiring gutter and lace together with twine or tie wraps to minimize chance of catching wire insulation on panel hardware.
- D. Connect panelboard branch circuit loads so that the load is balanced and distributed as equally as possible between the phase busses based on the actual installed equipment characteristics.
- E. Before energizing, verify and tighten all connectors, lugs, and mounting screws. Vacuum out all extraneous scraps of wire, plaster, dust, and other foreign material from inside the panelboard. Install dead-front shield.
- F. Complete circuit directory cards giving clear, evident, and specific nature of each load served. Description shall have sufficient detail to uniquely distinguish each circuit from all others. Completed circuit directory cards shall be type written. Install circuit directories in each panelboard.
- G. Install markers on the front cover of all panelboards which identify the voltage, current, and phases. Markers shall be made of self sticking B-500 vinyl cloth printed with black characters on an Alert Orange background, 2-1/4-in high by 9-in wide, Style A as manufactured by W.H. Brady Co. or approved equal.
- H. Install panelboard nameplates as shown on the Drawings and as specified in Section 26 05 00.
- I. [Install [manufacturer's standard] arc flash warning labels in conformance with NEC 110.16] [Install [manufacturer's standard] arc flash warning labels [in conformance with Section 26 05 73]].
- J. Perform final cleanup of panel interior with vacuum. Compressed air shall not be used.

3.02 FIELD QUALITY CONTROL

- A. Acceptance testing of the panelboard shall be per the requirements of Section 26 08 00.
- B. Periodically inspect panelboard during startup while under load. Verify temperature of panelboard cover surface. If surface is excessively hot, de-energize panelboard and notify the Engineer.

END OF SECTION

SECTION 26 24 19

MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work included:

1. Furnish, install and test the motor control centers as shown on the Drawings in accordance with these Specifications.
2. Motor control centers shall be sized to include all equipment, spares and spaces as shown on the Drawings.
3. The Contractor shall coordinate the size of the motor control center foot print with the size of the equipment pad and the size of the buildings in which the MCCs are to be installed.
4. The Contractor shall coordinate conduit stub up locations with the size and foot print of the motor control centers provided.
5. Motor control centers designated as Intelligent MCCs shall be fully configured for network integration into the Owner's SCADA system. Starters, drives, network switches, and other networkable equipment shall be provided with network ports which support [Ethernet/IP, Modbus TCP, Profibus] protocol and are fully compatible with the Owner's SCADA system as shown on the Contract Documents. [All motor control centers on this Project are designated as Intelligent MCCs.] [The motor control centers designated as Intelligent MCCs for this project are:
 - a. MCC-XXX]
6. Where shown on the drawings or specified herein, the motor control centers shall be installed in walk-in, structures. The motor control centers shall be shipped to the enclosure fabricator/integrator for installation prior to shipment of the fully assembled outdoor MCC to the project site. The Contractor shall be responsible for coordinating shipment of the MCCs from the MCC manufacturer to the enclosure fabricator/integrator, and ensuring that the assembled package is delivered to the project site to meet the schedule requirements of the Project.

B. Related sections:

1. Section 01 61 20 – Seismic Design Criteria
2. Section 26 05 00 - Common Work Results for Electrical
3. Section 26 08 00 - Commissioning of Electrical Systems
4. Section 26 22 13 – Low Voltage Dry Type Distribution Transformers
5. Section 26 24 16 – Panelboards
6. Section 40 61 00 – Process Instrumentation and Controls – General Provisions

1.02 QUALITY ASSURANCE

- A. The motor control centers shall be the product of a manufacturer who shall also be the manufacturer of all the circuit breakers, fused switches, motor starters, reduced voltage solid state starters, variable frequency drives which are included in the motor control centers.
- B. Motor control centers shall be designed, assembled and tested by the manufacturer of the motor control equipment included in the control center assembly.
- C. System integrators or fabrication shops that provide custom control wiring for motor control centers shall be a UL listed and certified shop.
- D. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified

1.03 SUBMITTALS

- A. Submittals shall be in accordance with Sections 01 33 00 and 26 05 00.
- B. The Contractor shall furnish submittals for approval as outlined below:
 - 1. Equipment outline drawings showing elevation and plan views, dimensions, weight, shipping splits, conduit entrance and metering layouts. Indicate all options, special features, and ratings
 - 2. Itemize and define any proposed deviations from the Specifications.
 - 3. Unit summary tables showing detailed equipment description and nameplate data for each compartment.
 - 4. Product data sheets and catalog numbers for all integral components such as overcurrent protective devices, motor starters, variable frequency drives, control relays, control stations, meters, pilot lights, etc. List all options, trip adjustments and accessories furnished specifically for this Project.
 - 5. Single line diagram and interconnection diagrams showing wire and terminal identification numbers.
 - 6. Heating and cooling calculations for each panel supplied indicating conformance with cooling requirements of the supplied equipment and environmental conditions. Calculations shall include the recommended type of equipment required for both heating and cooling that will ensure maintaining the integrity of the NEMA panel rating.
 - 7. Drawing indicating final IP addresses for each device and conform to specified Owner addressing requirements. Standard or generic diagrams will not be acceptable.
 - 8. Details of the remote network communications interface. Submit network module data sheets and memory mapping. Submit device parameter list with all data variables available for remote monitoring over the network interface. List shall include variable internal name, descriptive field that fully describes the contents and use of the variable, memory address and bit size, variable type (analog, discrete, text), engineering units, and function (e.g., status, alarm, internal diagnostic, etc.). Include complete configuration instructions including addressing, register allocation, data mapping, and options.
 - 9. Network access requirements including method for accessing equipment variables, software features, and physical hardware interface details.

10. Submit network communications factory testing procedures. Procedures shall include method for 100% testing of all variables associated with each motor starter, power monitor, adjustable speed drive, and other equipment associated with the MCC as specified. Procedure shall include factory test forms with sign-off sheets indicating proper transmittal and receipt of each variable, properly scaled, and addressed in conformance with the manufacturer's standard documentation. Include verification of each device IP address conforming to Owner standards.
 11. Submit details of configuration software used for intelligent overloads, starters, and drives. All software specified shall be licensed to the Owner.
 12. Submit detail and test plan for field verification of the network communications interface including verification of data receipt to the designated server as shown on the Drawings.
- C. Submit anchorage calculations per the requirements of Section 01 61 20.
- D. Seismic certification and equipment anchorage details as specified.
- E. Operations and maintenance manual
1. Instruction and renewal parts books.
 2. Itemized list of spare parts furnished specifically for this Project, including quantities, description and part numbers.
 3. Protective device time-current characteristics.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Refer to Common Work Results for Electrical, Section 26 05 00.

1.05 REFERENCE STANDARDS

- A. Motor control centers shall be designed, built and tested in accordance with the latest editions and revisions of NEMA Standard ICS-2 and Underwriters' Laboratories Standard No. UL-845. Equipment shall conform to ANSI C19.3 test standards and the requirements of the National Electric Code.
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.
- C. Institute of Electrical and Electronic Engineers/American National Standards Institute
1. IEEE/IEEE 62.45 – Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) Power Circuits
 2. IEEE/ANSI 62.62 – Standard Test Specifications for Surge-Protective Devices (SPDs) For Use On The Load Side of the Service Equipment in Low-Voltage (1000 V and Less) Power Circuits
- D. National Electrical Manufacturers Association (NEMA):
1. NEMA ICS 18 – Motor Control Centers
- E. Underwriters Laboratories (UL).
1. UL 489 – Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures

2. UL 508 – Industrial Control Equipment
3. UL 845 – Motor Control Centers
4. UL 1499 – Transient Voltage Surge Suppressors
5. UL 1066 – Insulated Case, Power Circuit Breakers

1.06 JOB CONDITIONS

- A. Refer to Common Work Results for Electrical, Section 26 05 00.

1.1 MANUFACTURER'S FIELD SERVICES

A. Installation.

1. Manufacturer's representative shall be present at the site for a minimum of 4 hours for assistance, startup, testing and certification. Travel time not included.
2. Submit a manufacturer's certificate of proper installation upon successful completion of the field testing and startup effort per the requirements listed in Paragraph 3.3.

B. Testing.

1. The manufacturer's service technician shall provide calibration, inspection and adjustments per the requirements in Paragraph 3.3.

PART 2 - PRODUCTS

2.01 MOTOR CONTROL CENTERS

A. Ratings.

1. Service type and voltage ratings shall be as shown on the Drawings.
2. The overall short circuit withstand and interrupt rating of the equipment and devices shall be as shown on the Drawings. Main and feeder circuit protective devices shall be fully rated for the specified short circuit duty. Systems employing series connected ratings for main and feeder devices shall not be used. Motor starter units shall be tested and UL labeled for the specified short circuit duty in combination with the motor branch circuit protective device.
3. The continuous current rating of the main horizontal bus shall be as shown on the Drawings. Vertical busses shall be sized for the structure and electrical loads installed in the section, and shall have a minimum rating of 300 amperes. Bus bracing shall equal or exceed the specified equipment short circuit rating.
4. Motor control centers, including devices, shall be designed for continuous operation at rated current in a 40 degree C ambient temperature.

B. Construction.

1. Enclosure type shall be NEMA Type 12.
2. Motor control centers shall consist of a series of metal enclosed, free-standing, dead front vertical sections bolted together to form double wall construction between sections. Individual vertical sections shall be nominally 90-in high, 20-in wide and 20-in deep unless otherwise shown on the Drawings. Bottom channel sills shall be mounted front and rear of the vertical sections extending the full width

of each shipping split. Top of each section shall have removable plates with lifting angle. Make provisions for field installation of additional sections to each end and provide full depth cover plates (rodent barriers) at each end of the motor control center channel sills.

3. Provide continuous top and bottom horizontal wireways extending the full width of the line-up, isolated from the horizontal bus. Provide a 9-in high horizontal wireway at the top and at the bottom in each section. Provide a 4-in wide, full height, vertical wireway in each section, equipped with a hinged door and cable supports. Vertical wireway shall be isolated from the bus and device compartments. Wireways openings shall have rolled edges or protective grommets.
4. Provide individual, flange formed, pan type door with concealed hinges and quarter turn latches for each device compartment and future space. Doors shall be removable. Door removal shall not be required to withdraw starter units or feeder tap devices.
5. Motor control centers shall be designed for against-the-wall mounting or back-to-back mounting if shown on the Drawings. All wiring, bus joints and other mechanical parts requiring tightening or other maintenance shall be accessible from the front or top.
6. Enclosures mounted on a raised concrete housekeeping or equipment pad shall include operator extension handles for the upper operator controls to comply with the NEC "Two Meter" rule.
7. NEMA 3R enclosure types consist of a NEMA 1 Gasketed enclosure mounted on a special base with an outdoor house erected around the enclosure. The outdoor house enclosure shall be non-walk-in.

C. Unit Compartments

1. Provide individual compartments for each removable combination starter and feeder tap device unit. Each vertical section shall accommodate a maximum of six compartments. Steel barriers shall isolate the top, bottom and sides of each compartment from adjacent units and wireways. Removable units shall connect to the vertical bus in each section with tin plated, self aligning, pressure type copper plug connectors. Size 5 and larger starter units may be wired directly to the bus. Removable units shall be aligned in the structure on guide rails or shelves and secured with a cam latch mechanism or racking screw.
2. Provide individual, isolated compartments for fixed mounted devices such as circuit breakers, cable lugs, metering, relaying and control devices. Main and bus tie circuit breakers shall be wired directly to the main horizontal bus. All bus connections shall be fully rated.
3. Provide the following features:
 - a. Provision to padlock removable units in a partially withdrawn TEST position, with the bus stabs disengaged.
 - b. Provision to padlock unit disconnect handles in the OFF position with up to three padlocks.
 - c. Mechanical interlock with bypass to prevent opening unit door with disconnect in the ON position, or moving disconnect to the ON position while the unit door is open.
 - d. Mechanical split-type terminal blocks for disconnecting external control wiring.

- e. Auxiliary contact on unit disconnect to isolate control power when fed from an external source. *** Coordinate with control schematics ***
- f. Disconnect operating handles and control devices mounted on the removable doors or device panels.
- g. Compartments containing motor starters shall have wiring diagrams and heater tables fastened to the compartment door. Compartments containing panelboards shall have circuit directories fastened to the compartment door.

D. Bus Systems

- 1. Main horizontal bus: Silver plated copper, bolted joints, accessible from the front of the structure, fully rated throughout the lineup. Rating of the horizontal bus shall be per the rating of the MCC.
- 2. Vertical section bus: Tin plated copper, full height, totally insulated and isolated by glass polyester barriers with shutters to cover stab openings when units are withdrawn. Provide fishtape barriers to isolate bottom wireways from lower ends of vertical bus. Vertical bus rating shall be [300][600][800][1200].
- 3. Vertical buses used for a tie circuit breaker or tie feeder lugs shall be rated for a continuous capacity equivalent to the main horizontal bus rating.
- 4. Horizontal ground bus: Provide a tin plated copper ground bus in each section equipped with lugs for termination of feeder and branch circuit ground conductors. Connect to ground bus in adjacent sections with splice plates where shipping splits are present. Minimum ground bus rating shall be 300A.
- 5. Neutral bus: For four wire systems provide a fully rated neutral bus along the entire length of the MCC lineup.

E. Wiring

- 1. Wiring: Stranded copper, minimum size No. 14 AWG, with 600 volt, 90 degree C, flame retardant, Type MTW thermoplastic insulation, NEMA Class II, Type [A], [B], [C]. Line side power wiring shall be sized for the full rating or frame size of the connected device.
- 2. Identification: Numbered sleeve type wire markers at each termination point, color coding per NEMA Standards and the NEC. Foreign voltage control wiring shall be yellow.

F. Signage

- 1. Each motor control center shall be furnished with a sign marked "DANGER - 480 VOLTS - KEEP OUT". Letters shall not be less than 1-in high, 1/4-in stroke. Signs shall be laminated plastic, engraved white letters with a red background.
- 2. Compartments with voltages from sources outside of the compartment shall have a sign mounted inside the compartment door marked "CAUTION - THIS UNIT CONTAINS A VOLTAGE FROM AN EXTERNAL SOURCE". Letters shall be white on a high visibility red background.

G. Surface Preparation and Shop Coatings

- 1. All non-current carrying metal parts of the control center assembly shall be cleaned of all weld spatter and other foreign material and given a heat cured, phosphatized chemical pre-treatment to inhibit rust.

2. Indoor equipment shall be finish painted with one coat of manufacturers standard electrocoated, heat cured enamel.
3. Outdoor equipment shall be finish painted with two coats of polyurethane or epoxy enamel, 2 to 3 mil thickness. Exterior color shall be ANSI 61 light grey.
4. Unpainted non-current carrying parts shall receive a protective zinc plating to prevent corrosion.

H. Manufacturers:

1. Eaton/Cutler-Hammer "Freedom 2100".
2. General Electric (ABB) "Evolution Series E9000"
3. Square D/Schneider Electric "Model 6"
4. Approved equal

2.02 COMPONENTS

A. General

1. The Drawings indicate the approximate horsepower and intended control scheme of the motor driven equipment. Provide the NEMA size starter, circuit breaker trip ratings, and control power transformers ratings matched to the motors and control equipment actually supplied, in compliance with the National Electrical Code. All variations necessary to accommodate the motors and controls as actually furnished shall be made without extra cost to the Owner.

B. Main Circuit Breaker

1. Main circuit breaker greater than 1200A frame, shall be, insulated case type circuit breaker, individually mounted, 3 Pole, 600 Volt, 100 percent rated with a removable electronic trip plug in type device.
2. Main circuit breaker less than or equal to 1200A frame shall be, molded-case circuit breaker, individually mounted, 3 Pole, 600 Volt, [80] [100] percent rated with a removable electronic trip plug in type device.
3. Main circuit breaker shall meet UL489 listing requirements.

C. Electronic Trip Device

1. The device shall be a digital solid state type with true rms current sensing to provide protection from overloads, short circuits, and ground fault protection. Device shall include short circuit, overload, and ground fault indicators. At a minimum the following adjustable trip parameters shall be included:
 - a. Long time pickup, adjustable from 50% to 100% of the rating plug value.
 - b. Long time delay with inverse time characteristics.
 - c. Short time pickup and delay with I²t.
 - d. Adjustable instantaneous pickup
 - e. Ground fault pickup adjustable from 40% to 100% of the rating plug value.
 - f. Ground fault delay with inverse time characteristics.
2. Electronic trip device shall be Eaton Corporation/Cutler Hammer Digitrip 310, General Electric (ABB) MicroEntelliGuard, or Equal.

3. Acceptable Manufactures:
 - a. Eaton Cutler Hammer, Series C or Magnum DS (Magnum DS used for insulated case power circuit breaker)
 - b. General Electric (ABB) Spectra RMS or Power Break II (Power Break II used for insulated case power circuit breaker)
 - c. Approved equal.

D. Feeder Circuit Breakers

1. Feeder circuit breakers with a trip rating greater than 150A shall be molded case, group mounted, 3 Pole, 600 Volt, 80 percent equipment rated, plug-in type with electronic trip device.
 - a. Electronic trip device shall be a digital solid state type with true rms current sensing to provide protection from overloads, short circuits and ground faults. Device shall include short circuit, overload and ground fault indicators. At a minimum the following adjustable trip parameters shall be included:
 - 1) Long time pickup, adjustable from 50% to 100% of the rating plug value.
 - 2) Long time delay with inverse time characteristics.
 - 3) Short time pickup and delay with I^2t .
 - 4) Adjustable instantaneous pickup
 - b. Electronic trip device shall be General Electric (ABB) MicroEntelliGuard, Eaton Corporation/Cutler Hammer Digitrip 310 or Equal.
2. Feeder circuit breakers less than or equal to 150A rating shall be molded case, group mounted, 3 Pole, 600Volt, plug-in type with fixed thermal magnetic type breaker.
3. Feeder circuit breaker shall meet UL489 listing requirements.
4. Trip unit and frame rating shall be as shown on the Drawings.
5. Acceptable Manufactures:
 - a. Eaton Cutler Hammer, Series C
 - b. General Electric (ABB), Spectra RMS
 - c. Approved equal.

E. Combination Starter Units

1. Combination starters shall be plug-in type including a motor circuit protector (MCP) in series with a motor controller and an overload protective device. The MCP shall have an adjustable magnetic trip range of rated continuous current and a trip test feature. MCPs shall be labeled in accordance with UL 489.
2. Motor starters: 3 pole, 600 volt, electrically operated, of the types shown on the Drawings. Provide NEMA sizes as required for the horsepowers shown on the Drawings. Minimum size shall be NEMA Size 1. Fractional size starters are not acceptable. Starters shall have 120 volt encapsulated operating coils; individual control power transformers with primary and secondary fuses and silver cadmium oxide renewable line contacts.

3. Two-speed and reversing starters shall include two motor rated contactors mechanically and electrically interlocked so that only one device may be energized at any time. Two-speed starters shall be suitable for two-winding motor control.
4. Contactors: Electrically held, 120 VAC coil operator, suitable for tungsten, ballast, or resistive non-motor loads, with over current protection, control transformer and contact ratings and poles as shown on the Drawings.
5. Electronic Overload Relay: Thermal overload protection shall be provided using microprocessor electronic overload relays. Electronic overload relays shall be equipped with the following features:
 - a. Selectable trip class of 5, 10, 20, or 30 using dial or DIP switches.
 - b. Selectable manual, automatic, and remote reset type.
 - c. Phase loss protection with 10 second delay.
 - d. Current unbalance protection with 10 second delay.
 - e. Visual trip indication.
 - f. Normally open and normally closed auxiliary contacts with 300VAC, 10 Amp rating.
 - g. Acceptable Manufactures:
 - 1) General Electric (ABB), CR324X series
 - 2) Eaton Cutler Hammer, C440 series
 - 3) Approved equal.
6. Electronic Overload Relay: Thermal overload protection shall be provided using microprocessor electronic overload relays. Electronic overload relays shall be equipped with the following features:
 - a. On-board Ethernet, Modbus TCP communication
 - b. LEDs for status indication
 - c. Test/Reset button
 - d. Adjustable trip class (5 to 30)
 - e. General purpose I/O (minimum 2I/1O)
 - f. Protective functions with programmable trip level, warning level, time delay and inhibit window:
 - 1) Thermal overload
 - 2) Underload
 - 3) Jam
 - 4) Stall
 - 5) Phase loss
 - 6) Ground Fault
 - g. Voltage monitoring functions and summary including phase magnitude, over voltage condition, under voltage condition, and percent imbalance
 - h. Current monitoring functions and summary including phase average magnitude, percent of full load, and percent imbalance

- i. Power monitoring functions and summary including real, reactive, apparent, power factor and maximum monitored power demand
- j. Energy – kWh
- k. Diagnostic information:
 - 1) Run time and start history
 - 2) Device status
 - 3) Warning status
 - 4) Time to reset
 - 5) Trip status
 - 6) Time to overload trip
 - 7) History of last 5 warnings and trips
- l. Acceptable Manufactures:
 - 1) Allen Bradley, E3 Plus series
 - 2) General Electric (ABB), MM300 series
 - 3) Approved equal.
- 7. Auxiliary contacts: Form C, NEMA 600A rating, as required by the control schemes on the Drawings. Provide 1-normally open and 1-normally closed spare contacts on each starter. Additional auxiliary contacts shall be furnished as shown on the Drawings or as required by the control schematic and Specifications.
- 8. Control power transformers: Two winding type, 120 VAC secondary, with primary and secondary fuses in accordance with the NEC. Provide a minimum 50% extra capacity.

F. Digital Multimeter (DMM)

- 1. Provide monitor with multiple configurable digital readouts. Meter shall be capable of monitoring and displaying individual phase voltage, individual phase current, kilowatts, kilovars, kilovars reactive, power factor, or energy as selected by the user. Accuracy shall be at least ± 0.25 % of full scale for voltage and current; ± 0.50 % of full scale for power and energy.
- 2. Provide user configurable 4-20 mA analog output and three user configurable discrete alarm output contacts. User configuration shall allow selection of desired variables and alarm trip point.
- 3. Provide fuse protected potential transformer and current transformers rated as required the feeder circuit monitored. Provide fuse protected 120V control power transformer for source power for the meter derived from the 480V or 240V feeder circuits.
- 4. Provide [Ethernet/IP][Modbus][DeviceNet] protocol and communication port.
- 5. Acceptable Manufactures:
 - a. Eaton Cutler Hammer, IQ Series
 - b. General Electric (ABB), Power Leader EPM
 - c. Approved equal.

G. Surge Protective Device (SPD)

1. The SPD shall be mounted integrally with the motor control center and shall be manufactured by the same manufacture as the switchboard.
2. The suppression voltage rating (SVR) shall be tested in accordance with UL-1449
3. The SPD device repetitive surge current capacity shall be tested per the requirements of ANSI/IEEE C62.62 and ANSI/IEEE C62.45.
4. The SPD shall have maximum surge current rating of 100,000 amperes per mode at the nameplate voltage rating of the switchboard. The rating shall be based on testing of a complete SPD unit including fuses and all components that make up the SPD system. Devices that derive a maximum surge current rating by adding test results of individual components are not acceptable.
5. Provide status indicator light, form C status relay for remote monitoring, and audible alarm with enable/disable switch.
6. Acceptable Manufacturer:
 - a. Eaton Cutler-Hammer/Clipper Power System, Visor Series
 - b. General Electric (ABB), Tranquell
 - c. Approved equal

H. Reduced Voltage Solid-State Starter (RVSS)

1. General: Provide reduced-voltage solid state motor starter housed in the Motor Control Center Structure complete with enclosure thermostatically controlled space heater and ventilation fan. RVSS components shall be tested in accordance with UL 508. The solid-state reduced-voltage starter shall be an integrated unit with power SCRs, logic board, paralleling bypass contactor, and electronic overload relay enclosed in a single molded housing.
2. The SCR-based power section shall consist of six (6) back-to-back SCRs and shall be rated for a minimum peak inverse voltage rating of 1500 volts PIV. Units using triacs or SCR/diode combinations shall not be acceptable. Resistor/capacitor snubber networks shall be used to prevent false firing of SCRs due to dV/dT effects. The logic board shall be mounted for ease of testing, service and replacement. It shall have quick disconnect plug-in connectors for current transformer inputs, line and load voltage inputs and SCR gate firing output circuits.
3. Starter shall be rated for operation between -10 to 50 degrees C ambient and suitable at altitudes up to 3300 feet without deration. Provide conformally coated logic boards for addressing site specific environmental concerns.
4. Provide paralleling run bypass contactor that energizes when the motor reaches 90% of full speed and close/open under rated full load motor current. The paralleling run bypass contactor shall utilize an intelligent coil controller to limit contact bounce and optimize coil voltage during varying system conditions.
5. Digital interface module mounted on the face of the unit shall be used to program the soft starter. Display shall include six line LED readout. Monitoring parameters shall include line currents, pole currents, pole voltages, number of starts, and DC control voltage. Soft starter shall display motor status and the previous 5 fault conditions.
6. Starter shall be provided with electronic overload protection as standard and shall be based on inverse time-current algorithm. Overload protection shall be capable of being disabled during ramp start for long acceleration loads via digital interface module. Overload protection shall be adjusted via the device keypad and shall

have a motor full load ampere adjustment from 30 to 100% of the maximum continuous ampere rating of the starter. Starter shall have selectable overload class setting of 5, 10, 20 or 30 via a DIP switch setting or the device keypad. Units using bimetal overload relays are not acceptable.

7. Starter shall be capable of either an electronic or mechanical reset after a fault.
8. Overtemperature protection (on heat sink) shall be standard.
9. Starters shall provide protection against:
 - a. Improper line-side phase rotation as standard executing and orderly shutdown if a line-side phase rotation other than A-B-C exists.
 - b. Phase loss or unbalance condition, shutting down if a 50% current differential between any two phases is encountered.
 - c. Motor stall condition
 - d. Motor jam condition
 - e. Protection features shall be able to be enabled or disabled via the RVSS digital interface module.
10. Reduced voltage starter shall be provided with UL listed, heavy duty industrial type power factor correction capacitors mounted as part of the motor control center lineup either in dedicated MCC buckets or in a separate enclosure mounted above the associated MCC section as required by the manufacturer.
 - a. Power factor correction capacitors shall be as recommended, selected, and furnished by the motor control center manufacturer to raise the motor power factor to approximately 95 percent.
 - b. Capacitors shall be dry film or liquid insulated and shall be hermetically sealed in steel enclosures.
 - c. Each capacitor unit shall be furnished with three high interrupting capacity current limiting fuses. Fuses shall be equipped with "blown-fuse" indicators.
 - d. Provide dedicated switching contactors for the capacitor banks integrated with the RVSS starting logic to switch the capacitors into the motor circuit upon completion of the RVSS startup ramping with motor receiving full voltage and at full speed.
11. Provide the following control function adjustments from digital interface module:
 - a. Selectable Torque Ramp Start or Current Limit Start
 - b. Adjustable Kick Start Time: 0–2 seconds
 - c. Adjustable Kick Start Torque: 0–85%
 - d. Adjustable Ramp Start Time: 0.5–180 seconds
 - e. Adjustable Initial Starting Ramp Torque: 0–85%
 - f. Adjustable Smooth Stop Ramp Time: 0–60 seconds
12. Provide linear pump ramp logic option to allow linear ramping of centrifugal pump load based on ramping parameters entered from the RVSS keypad.
13. Maximum continuous operation shall be at 115% of continuous ampere rating
14. Starter shall be provided with the following Form C digital output contacts:
 - a. Run

- b. Fault
 - c. High Temp
 - d. In Bypass
 - e. Ready
15. Unit shall have [DeviceNet][Modbus][Profibus] communication option.
16. Acceptable manufactures:
- a. Eaton/Cutler Hammer "S811"
 - b. General Electric (ABB) "ASTAT IBP"
 - c. Approved equal.

I. Variable Frequency Drive

1. Rating:
- a. Service Conditions
 - 1) Input power: 460 VAC, ± 10 percent, 3 phase, 60 Hz.
 - 2) Input frequency: 57 to 63 Hz.
 - 3) Ambient temperature: 0 degrees C to 50 degrees C.
 - 4) Elevation: Up to 3300 feet above mean sea level.
 - 5) Relative humidity: Up to 95 percent non-condensing.
 - b. Minimum drive efficiency: 97 percent or better at motor base speed and rated torque.
 - c. Displacement power factor: 95 percent or higher throughout the entire speed range, measured at drive input terminals.
 - d. Drive output: 100 percent rated current continuous at 50 degrees C, suitable for operation of the driven equipment over the required speed range without overloading. Drives shall be capable of a continuous overload up to 110 percent rated current for variable torque loads and 150 percent rated current for constant torque loads. Starting torque shall be matched to the load.
 - e. Output frequency drift: No more than plus or minus 0.5 percent from setpoint.
2. Construction:
- a. General
 - 1) The VFDs shall utilize a digital pulse width modulated (PWM) design to convert the fixed AC input to a variable voltage, variable frequency AC output. Construction shall be modular, using plug-in type component mounting or keyed ribbon cable connections wherever possible to minimize downtime during repair.
 - 2) The VFD shall operate satisfactorily when connected to a bus supplying other solid state power conversion equipment which may be causing up to 10 percent total harmonic voltage distortion and commutation notches up to 36,500 volt microseconds, or when other VFD's are operating from the same bus. The drive shall include transient voltage suppression to

allow reliable operation on a typical commercial power distribution system.

- 3) The VFD shall consist of a full-wave diode bridge converter to convert incoming fixed voltage/frequency to a fixed DC voltage. Provide a DC link choke smoothing reactor to limit fault throughput.
- 4) The VFD shall have an output voltage regulator to maintain correct output Volt/Hertz despite incoming voltage variations. The VFD shall have a continuous output current rating equal to or greater than the motor full load nameplate current.
- 5) The VFD shall be suitable for motor control center installation.
- 6) The VFD shall have a local circuit breaker disconnect. Provide current limiting fuses if required by the VFD manufacturer to maintain short circuit rating.

b. Operator interface

- 1) Provide a mounted digital keypad/display, capable of controlling the drive and setting drive parameters. The digital display shall normally display:
 - a) Speed demand in percent
 - b) Output current in amperes
 - c) Frequency in Hertz
 - d) Control mode manual or automatic
- 2) The digital keypad shall allow operators to enter exact numerical settings in English engineering units. A user menu shall be provided as a guide to parameter settings. Coded messages on keypad will not be acceptable. Parameters are to be factory set in EEPROM and resettable in the field. Parameters shall be password protected. The EEPROM stored variables shall be transferable to new and spare boards.
- 3) At a minimum the following controls and indicators shall be provided, either separately or as part of the keypad/display to match as shown on VFD control schematic:
 - a) LED indicators:
 - i) Power on
 - ii) Run
 - iii) Fault
 - iv) Motor high temperature
 - v) Elapse time meter
 - b) Controls:
 - i) Local-Off-Remote
 - ii) Start
 - iii) Stop
 - iv) Reset

- c. VFD circuit shall have auxiliary status and alarm contacts as shown on the Drawings. VFD shall, at a minimum, have the following auxiliary contacts:
 - 1) Run
 - 2) Fault
 - 3) High Temp
 - d. Provide [Profibus DP] [DeviceNet][Ethernet IP] [Modbus TCP] [LonWorks] [BacNet] communication module as shown on the control schematic
3. Protective and Operational Features:
- a. Make provisions for field adjustment of the following parameters through the keypad/display:
 - 1) Current limit and boost
 - 2) Voltage (Volts/Hertz)
 - 3) Frequency (Minimum and Maximum)
 - 4) Independently adjustable acceleration and deceleration rates
 - 5) Auto restart delay
 - 6) Up to five critical bands where drive operation is inhibited
 - b. Make provisions to accept a remote dry contact closure to start and stop the drive(s) with the drive control system in the AUTO mode.
 - c. Make provisions to accept a 4 to 20 mA DC input signal for remote speed control. Input shall be isolated at the drive and active with the drive control system in the AUTO/REMOTE mode. Zero and span adjustability shall be provided.
 - d. Provide the following internal protective features.
 - 1) Transient surge protection.
 - 2) Overcurrent protection.
 - 3) Current limit, inverse time type.
 - 4) DC bus fuse protection and discharge circuit.
 - 5) DC bus overvoltage trip.
 - e. Provide the following output protective features:
 - 1) The drive shall protect motor electronic motor overload protection of the motor. Provide with manual reset.
 - 2) Provide dv/dt filter if distance is greater than 100FT from the VFD to the motor.
 - f. Harmonic and Radio Noise Mitigation
 - 1) Harmonic mitigation equipment shall be provided to meet IEEE 519 requirements.
 - 2) Provide input line reactors if required to meet IEEE 519 requirements based on field harmonic testing as required in Section 26 08 00.
 - 3) Provide EMI/RFI filters to limit radio frequency noise in excess of the limits specified by FCC Docket 20780 (Part 15, Subpart J) or

if the drives create noise in a frequency range which will interfere with other sensitive equipment at the installation (such as lighting systems, telecommunications systems, instrumentation and monitoring equipment).

g. Provide a digital, non-resettable, motor run time elapsed time meter.

4. Diagnostic and Fault Capability:

a. The following conditions shall cause an orderly drive shutdown and lockout.

- 1) Incorrect phase sequence.
- 2) Blown input fuse or single phasing of supply.
- 3) Control power supply failure.
- 4) Instantaneous overcurrent.
- 5) Sustained overload.
- 6) Transistor overcurrent.
- 7) Motor overload.

b. Provide complete built-in diagnostic and test capability to enable maintenance personnel to rapidly and accurately identify the cause of equipment failure.

5. Acceptable Manufacturers:

- a. Eaton/Cutler Hammer "SVX9000"
- b. General Electric (ABB) "AF-600 FP"
- c. Approved equal

J. Relays and Timers

1. Control relays and timers: 300 volt, industrial rated, plug-in socket type, housed in a transparent polycarbonate dust cover, designed in accordance with UL Standard 508 for motor controller duty. Continuous contact rating shall be 10 amperes resistive, 1/4 HP, at 120 VAC, operating temperature minus 10 to plus 55 degrees C. Relays and timers shall be Potter & Brumfield KRP Series or approved equal with neon coil indicator light and calibrated timing knob or DIP settable controls.

K. Miscellaneous Units

1. Elapsed time hour meters: Five digit, non-reset type, with 120 volt synchronous motor.

L. Spare Parts: Spare parts shall be boxed or packaged for long term storage. Identify each item with manufacturers name, description and part number on the exterior of the package. Provide the following spare parts in the quantities specified for motor control centers:

1. One dozen each size of cover bolts, cage nuts and door fasteners.
2. Six cans of aerosol touch-up paint.
3. 50 percent replacement fuses, all types and sizes.
4. Two of each color replacement lens caps for LED pilot lights.
5. Six size 1 starter coils.
6. Two motor starter control modules of each type provided.

M. COMMUNICATIONS

1. MCC shall have Ethernet, Modbus TCP cabling integrated throughout the MCC in accordance with UL 845 procedures and practices. Ethernet, Modbus TCP implementation requirements shall be as specified in Section 40 61 00.
2. Provide manufacturers standard configuration and programming software for the intelligent devices provided. A single software package shall be used for all intelligent overloads, starters, and drives. Provide software with all licenses and authorization assigned to the District. Software shall be used by the Contractor for configuration, testing, and commissioning. Software shall be turned over to the District prior to Acceptance for installation on a District standard machine.
3. Each motor starter, drive, soft starter and spare unit compartment in the MCC shall be supplied with a means to communicate via Ethernet, Modbus TCP, and have the capability of monitoring all the required inputs as specified and per the manufacturer's standard interface.
4. Ethernet, Modbus TCP I/O interface module shall be pre-wired to each unit. Ethernet, Modbus TCP module shall be configured with a minimum auxiliary input output capacity of 4 discrete inputs and 2 discrete outputs.
5. The Ethernet, Modbus TCP data communications system shall be fully integrated into the factory lineup. The Ethernet, Modbus TCP system shall be installed, configured, and tested prior to on-site installation of the switchgear equipment. All Ethernet, Modbus TCP network transmission media for the MCC shall be provided for a complete system, including network cable, terminations, switches, and all required network hardware.
6. Ethernet, Modbus TCP network cable shall be Category 5 or better and conforming to the requirements of UL 845. All units shall be interwired and tested as Class II type B MCC. Ethernet, Modbus TCP cable shall have an insulating rating equal to at least the maximum circuit voltage applied to any conductor within the enclosure or raceway. Special separation, barriers, or internal conduit for the Ethernet, Modbus TCP conductors are not acceptable.
7. The addition and removal of an MCC motor control component from the lineup or the Ethernet network shall not interrupt the network operation of other units.
8. Ethernet, Modbus TCP cabling shall be routed through the MCC line-up, behind barriers that isolate the cabling unit space and wireways to prevent accidental mechanical damage during MCC installation.
9. Panel Mounted (Industrial Grade) Ethernet Switches
 - a. Provide industry-standard ultra wide IEEE 802.3u 100Base-TX and 100Base-FX autosensing Ethernet switches supporting Fast Ethernet communications over both fiber optic (FO) and copper cables. Provide managed Ethernet switches with a minimum of 20% spare ports or sixteen 100Base-TX ports and two 100Base-FX ports whichever is greater.
 - b. FO ports shall be single-mode type with type ST connectors.
 - c. Switch shall be standard DIN rail mount type for industrial application having a minimum operating temperature of 60 degree C, and listed for installation in a UL508 control panel.
 - d. Switches shall include an alarm relay contact output rated for 1 amp at 24VDC.
 - e. Switches shall be Moxa EDS-500 series, Stratix, N-Tron, or equal as recommended by the MCC manufacturer.

10. Provide Ethernet power supplies for serving the monitoring requirement of the installed starters, spare, and space units on the MCC. Full monitoring of the built out MCC lineup shall be available without additional power supplies.
11. The Ethernet, Modbus TCP address shall be assigned to each unit during factory configuration. IP addressing shall conform to Owner standards as specified in Section 40 61 00.
12. Each MCC installed network interface component (electronic overload, breaker trip unit, drive, etc.) shall have the following features at a minimum where applicable:
 - a. On-board Ethernet, Modbus TCP communication
 - b. LEDs for status indication
 - c. Test/Reset button
 - d. Adjustable trip class (5 to 30)
 - e. General purpose I/O (minimum 2I/1O)
 - f. Protective functions with programmable trip level, warning level, time delay and inhibit window:
 - 1) Thermal overload
 - 2) Underload
 - 3) Jam
 - 4) Stall
 - 5) Phase loss
 - 6) Ground Fault
 - g. Voltage monitoring functions and summary including phase magnitude, over voltage condition, under voltage condition, and percent imbalance
 - h. Current monitoring functions and summary including phase average magnitude, percent of full load, and percent imbalance
 - i. Power monitoring functions and summary including real, reactive, apparent, power factor and maximum monitored power demand
 - j. Energy – kWh
 - k. Diagnostic information:
 - 1) Run time and start history
 - 2) Device status
 - 3) Warning status
 - 4) Time to reset
 - 5) Trip status
 - 6) Time to overload trip
 - 7) History of last 5 warnings and trips

N. HVAC SYSTEM

1. Where required for component cooling and satisfactory operation, provide MCC walk-in enclosures with [redundant, two full-capacity units] air conditioning system. AC units shall be rugged, corrosion-resistant, industrial-type units with proven reliability in wastewater treatment applications. Each air conditioning unit shall

operate on 480V 3-phase power supply from the associated MCC equipment with internal control step-down transformer to provide 24VAC for thermostat circuits.

2. The air conditioner housing shall be constructed of stainless steel. The evaporator and condenser of the air conditioner shall be coated with a phenolic coating for added corrosion protection. Industrial corrosion-resistant coatings shall be applied to external coils and housings for added protection. Condensate pans and piping shall be stainless or non-metallic and arranged to prevent condensate leaking into the structure.
3. The air conditioning units shall be equipped with an internally mounted economizer unit with an automatic damper to allow the enclosure to be cooled with external ambient air when the outside air temperature is lower than the interior temperature.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Motor control center floor sills shall be bolted directly to the finished floor or equipment pad per submittal approved anchorage calculations. Structure shall be leveled and plumb. Anchor bolts shall be as sized per Section 01 61 20. Provide hardware and shims for installation.
- B. Field installed interior wiring shall be neatly grouped by circuit and bound by plastic tie wraps. Circuit groups shall be supported so that circuit terminations are not stressed.
- C. In general, all conduit entering or leaving a motor control center shall be stubbed into the bottom or top horizontal wireway directly below or above the vertical section in which the conductors are to be terminated.
- D. Housekeeping pads shall be included for the motor control centers as detailed on the Drawings.
- E. Install the equipment in accordance with the manufacturer's instructions.
- F. Remove temporary lifting angles, lugs and shipping braces. Touch-up damaged paint finishes.
- G. Make wiring interconnections between shipping splits.
- H. Install bus splice plates and torque connections.
- I. Seal all seams, cracks, or openings in outdoor enclosures.

3.02 FACTORY QUALITY CONTROL

- A. The motor control center shall be tested per the manufactures standard factory tests.

3.03 FIELD QUALITY CONTROL

- A. The Contractor shall make provisions for acceptance testing per the requirements of Section 26 05 00.

- B. In the event of an equipment fault, notify the Engineer immediately. After the cause of the fault has been identified and corrected, a joint inspection of the equipment shall be conducted by the Contractor, the Engineer and the equipment manufacturer's factory service technician. Repair or replace the equipment as directed by the Engineer prior to placing the equipment back into service.
- C. All as-built drawings shall be corrected and verified for correctness of in-field changes by the Contractor prior to submittal to the Engineer for final review.

3.04 CLEANING

- A. Remove all rubbish and debris from inside and around the control center. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint-free rags. Do not use compressed air.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES - POWER AND DISTRIBUTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work included:

1. Furnish all labor, materials, and equipment and install wiring devices as shown on the Drawings and as specified herein.

1.02 RELATED SECTIONS:

1. Section 26 05 00 – Common Work Results for Electrical
2. Section 26 05 33 – Raceway and Boxes

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 26 05 00.

B. Submit annotated catalog cuts for all wiring devices provided under this contract. Annotation shall indicate the specific product type, rating, and application for each device provided.

1.04 REFERENCE STANDARDS

A. Wiring devices shall comply with the requirements of the 2022 California Electrical Code (NEC).

B. Federal Specifications (FS)

1. FS WS 896: Switches, Toggle (Toggle and Lock), Flush Mounted General Specification
2. FS WC 596: General Specification For Connector, Electrical Power,

C. American National Standards Institute (ANSI)/National Electrical Manufacturer's Association (NEMA)

1. ANSI/NEMA WD1: General Color Requirements for Wiring Devices
2. ANSI/NEMA WD6: Wiring Devices/Dimensional Requirements

D. American Society for Testing and Materials (ASTM)

1. ASTM A193: Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications

E. Underwriters Laboratories (UL)

1. UL 20: General Use Snap Switches

2. UL 498: Attachment Plugs and Receptacles
 3. UL 514A: Metallic Outlet Boxes
 4. UL 514C: Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
 5. UL 943: Ground-Fault Circuit-Interrupters
 6. UL 1449: Surge Protection Devices
- F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

PART 2 - PRODUCTS

2.01 WALL SWITCHES

- A. Switches shall be heavy duty, industrial specification grade, toggle action, flush mounting quiet type with ground screw terminal. Provide switches in conformance with NEMA WD1, FS WS-896, and UL 20.
- B. Provide 1-pole switches unless multi-pole switches are shown on the Drawings or if required to achieve the lighting control requirements indicated.
- C. Toggle switch shall be ivory color.
- D. Rating shall be 20A, 120/277 Volt with maintained contacts. Where shown on the Drawings provide momentary contact, 3-position, 2-circuit with center off style switches for application with lighting contactors as specified in Section 26 50 00.
- E. Provide switches with back and side wire terminals accepting up to #10 AWG stranded or solid conductors. Provide grounding screw terminal.
- F. Acceptable manufacturers:
 1. Cooper Wiring Devices, Inc. type E-1
 2. Hubbell, Inc.
 3. Approved equal

2.02 DUPLEX RECEPTACLES – GENERAL PURPOSE TYPE

- A. Duplex receptacles shall be, industrial specification grade, straight blade, 2 pole, 3 wire grounding type with contact made on two sides of the inserted blade. Provide in conformance with ANSI/NEMA WD1, FS WC 596, and UL 498. Provide isolated ground type where shown on the Drawings.
- B. Rating shall be 20A, 125Volt.
- C. High impact and chemical resistant nylon face. Provide corrosion resistant marine duty type where located in NEMA 3R, NEMA 4, or NEMA 4X locations as shown on the Drawings and in conformance with Section 26 05 00. Provide face color ivory for standard applications; orange face for isolated ground applications; red face when powered from emergency or uninterruptible power sources.
- D. NEMA configuration 5-20R per ANSI/NEMA WD6.

- E. Acceptable manufactures:
 - 1. Cooper Wiring Devices, Inc. type G-7; type G-9 for isolated ground applications; type M-1 for corrosion resistant, marine grade units.
 - 2. Hubbell, Inc.
 - 3. Approved equal

2.03 DUPLEX RECEPTACLES - GROUND FAULT CIRCUIT INTERRUPTER (GFCI) TYPE

- A. Provide GFCI type, industrial specification grade, 20 Amp, 125 Volt, 2 Pole, 3 Wire, feed thru type with "test" and "reset" buttons in conformance with UL 943. Units shall trip at 5mA.
- B. Provide corrosion resistant marine duty type where located in NEMA 3R, NEMA 4, or NEMA 4X locations as shown on the Drawings and in conformance with Section 26 05 00.
- C. NEMA 5-20R configuration per ANSI/NEMA WD6. Units shall fit standard size boxes and be compatible with standard device plates.
- D. Acceptable Manufactures:
 - 1. Cooper Wiring Devices, Inc. type GFCI
 - 2. Hubbell, Inc.
 - 3. Approved equal

2.04 DUPLEX RECEPTACLES – SURGE SUPPRESSION TYPE

- A. Provide transient voltage surge suppression (TVSS) type receptacles where shown on the Drawings. Provide 20A, 125Volt, 2 Pole, 3 Wire grounding type in NEMA 5-20R configuration, hospital grade conforming to UL 1449.
- B. Provide hot to neutral and hot to ground surge protection with clamping voltage of 400 Volts maximum and providing a minimum of 280 Joules of surge protection in each mode.
- C. Provide units having visual indication of the functionalities of the TVSS receptacle. Units shall have an audio alarm indication upon loss of ground or when surge protection is no longer functioning. Audio alarm shall include a front accessible alarm mute function.
- D. Acceptable manufacturers:
 - 1. Cooper Wiring Devices, Inc. Type J1
 - 2. Hubbell
 - 3. Approved equal

2.05 THREE-PHASE POWER OUTLETS

- A. The power outlets shall be 3-phase, 4 or 4 wire power receptacles for cord connected devices. Provide associated manufacturer's standard backboxes and cover plates conforming to the NEMA rating of the location as shown on the Drawings.

- B. Receptacle configuration shall match standard NEMA plug and receptacle requirements of the connected load as shown on the Drawing or as required by the equipment manufacturer.
- C. For plug and receptacle connections for motor driven equipment provide outlets incorporating integral mechanical interlock switches.
- D. Special-Purpose Receptacles: Receptacles shall have a matching plug with cord-grip features meeting UL 1686 C1.
- E. Receptacles shall be watertight construction, mounted in environmentally suitable boxes with a gasketed "Constant Use" weatherproof device plate and boot.
- F. Provide outlets as manufactured by Hubbell, Cooper, Appleton, or equal.

2.06 MULTI-OUTLET RACEWAY ASSEMBLIES

- A. Provide surface mounted raceway, multi-outlet wiring system for branch circuit wiring and high density convenience receptacle installations where shown on the Drawings.
- B. Provide units in standard manufactured lengths. Units shall be of two piece design with removable cover made of manufactured steel. Base units shall have ½" trade knockouts for and covers shall have blank or prepunched cuts for receptacle installation on uniform centers.
- C. Provide laboratory specification grade receptacle. Rating shall be 15A, 125 Volt, NEMA configuration 5-15R and conforming to UL 498.
- D. Provide multi-outlet raceway systems with factory wired receptacles. Each receptacle shall be in an isolated ground configuration.
- E. Assemblies shall be installed and configured using manufacturer's standard mounting hardware, connectors, and fittings. Unit color shall be field coordinated with the installation and suitable for field repainting.
- F. Provide two piece multichannel configuration for multiple system usage where shown on the Drawings.
- G. Acceptable manufacturers:
 1. Wiremold (subsidiary of Legrand), Plugmold Systems Series 2000 (single channel) or Series 4000 (multichannel) as required.
 2. Hubbell
 3. Approved equal

2.07 FLOOR BOX ASSEMBLIES

- A. Provide dual service poke-through type service pedestals where shown on the Drawings.
- B. Pedestals shall be UL Classified under UL 514 for fire ratings equal to or greater than the fire rating of the floor where the device is installed.

- C. Service fitting heads shall each contain a 20 Amp, 125 Volt, 2 Pole, 3 Wire duplex receptacle on one side and provisions for telephone, network, or other systems as shown on the Drawings.
- D. Poke-thru service fittings shall be installed in core drilled hole and fit floor thicknesses of 2-1/2-in to 7-in. Provide poke-through assemblies installed and configured using manufacturer's standard mounting hardware, connectors, and fittings.
- E. Acceptable manufacturers:
 - 1. Wiremold (subsidiary of Legrand), type FIT or RC9 as required
 - 2. Hubbell
 - 3. Approved equal

2.08 DEVICE PLATES

- A. Plates for indoor flush mounted devices shall be of the required number of gangs for the application involved and shall be applied where shown on the Drawings and per Section 26 05 00 as follows:
 - 1. NEMA 1: Smooth, high impact nylon of the same manufacturer and color (ivory) as the device.
 - 2. NEMA 4X, 4, and 12: Stainless steel, brushed with stainless steel mounting screws.
- B. Plates for devices surface mounted outdoors shall be weatherproof.
 - 1. Weatherproof receptacles shall have a gasketed weatherproof coverplate. Mounting screws shall be Type 304 stainless steel.
 - 2. Weatherproof switches shall have a gasketed, weatherproof, cast metal cover plate incorporating an external operator for the internal switch. Mounting screws shall be Type 304 stainless steel in accordance with ASTM A193.
- C. Provide plates for device boxes by the same manufacturer as the device and of the same material as the box (metallic or non-metallic) per Section 26 05 33.
- D. Multiple surface mounted devices shall be ganged in a single, common box and provided with an adapter, if necessary, to allow mounting of single gang device plates on multi-gang cast boxes.
- E. Provide engraved device plates indicating function, circuit name, or characteristics where specified.
- F. Provide UL Listed weather protected "Constant Use" cover over plug ends of cord connected equipment located in NEMA 3R, NEMA 4, and NEMA 4X locations. Provide single or two gang box cover made of polycarbonate configured in a vertical arrangement. Provide protective cover having neoprene covers, gaskets, and suitable for application on 120V, 3 Wire, 20 A devices or other configuration where required. Cover Constant Use covers by same manufacture as the receptacle.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The locations of devices are shown diagrammatically on the Drawings and may be varied within reasonable limits so as to avoid piping, equipment, or other obstruction. Coordinate the final installation location of the devices with piping and equipment clearances and to conform to the requirements of the NEC. Any such relocation of wiring device locations shall be coordinated with the Owner and shall be performed at no addition to the Contract bid price.
- B. Devices shall be installed in conformance with manufacturer's recommendations. Manufacturer's recommended fittings and hardware shall be used in all cases.
- C. Faces of switches and receptacles shall be installed flush with the finished wall surfaces in NEMA 1 areas shown on the Drawings. Lighting switches shall be installed on the lock side of doors.
- D. Devices installed in areas designated NEMA 3R, 12, 4, or 4X on the Drawings shall be surface mounted.
- E. Provide weatherproof device covers for all wiring devices installed in areas designated NEMA 3R, NEMA 4, or NEMA 4X on the Drawings and per Section 26 05 00.
- F. Provide GFI receptacles with "Constant Use" covers for cord connected equipment operated in areas are, or may be damp or locations near water sources. Examples are sump pumps, sample pumps, analyzers, etc. or where shown on the Drawings.
- G. Mount receptacles as follows unless noted otherwise on the drawings:
 - 1. 12-inches above the finished floor in NEMA 1 areas
 - 2. 48-inches above the finished floor or grade in below grade vaults, structures, and other process areas rated NEMA 4 or NEMA 4X.
 - 3. 18-inches above the finished floor in NEMA 12 areas
- H. Device Plates
 - 1. Plates shall fit closely and tightly to the box on which they are installed.
 - 1. Plates on surface-mounted boxes shall not extend beyond the sides of the box unless the plates do not have sharp corners or edges.
 - 2. The plate material shall be compatible with the box material to prevent galvanic corrosion.
 - 3. Oversized plates shall be installed where standard plates do not fully cover the wall opening.
- I. GFCI Installation
 - 1. Use of feed-through circuiting through receptacles may be used where ground-fault circuit protection is required for groups of receptacles. Feed through circuiting shall only be used for up to three receptacles maximum
 - 2. For applications with heat trace heating tape, provide GFCI protected breakers having adjustable sensitivity trip setting as specified per Section 26 24 16. The use of GFCI receptacles for these applications is not acceptable.

END OF SECTION

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SECTION 26 50 00

LIGHTING

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required and install a complete lighting system ready for operation as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- 1. Section 26 05 00 – Common Work Results for Electrical
- 2. Lighting fixture types referenced on the Drawings and associated descriptions are included under Appendix 26 50 00-A – Lighting Fixtures.

1.03 SUBMITTALS

- A. Submittals shall include those set forth in Section 26 05 00 and shall be in accordance with Section 013 33 00.
- B. The submittals shall contain the following product information as a minimum:
 - 1. Fixtures: Manufacturer, model number, materials of construction, finish type and color, total fixture wattage (ballast plus lamp), mounting hardware.
 - 2. Ballasts: Manufacturer, model number, total harmonic distortion, crest factor, external wiring diagram, power factor.
 - 3. Drivers: operational and control features, total harmonic distortion, power factor.
 - 4. Lamps: Manufacturer, model number, wattage, color temperature, color rendition index, mean lumen output, rated life.
 - 5. Fixture photometric data in ANSI/IESNA LM-63-02 standard format.
- C. All light-emitting diode (LED), fluorescent fixtures (except compact fluorescent), and ballasts shall be provided with certification from the manufacturer that they bear the Environmental Protection Agency (EPA) and the Department of Energy (DOE) ENERGY STAR® label and California Code of Regulations (CCR) Title 20 self-certification.
- D. LED fixture submittals shall include manufacturer's standard LED Lighting Facts label.
- E. Submit lighting control panel interior and exterior elevation drawings to scale, schematic control diagrams, and bill of materials indicating the details of the panels and application for controlling the associated lighting fixtures.

1.04 REFERENCE STANDARDS

- A. American National Standards Institute (ANSI)
 - 1. C78.377 – Specifications for the Chromaticity of Solid-State Lighting Products

2. C82.11 – High-Frequency Fluorescent Lamp Ballasts
 3. ESD S20.20 – Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)
 4. C78.23 – Incandescent Lamps – Miscellaneous Types
- B. California Code of Regulations (CCR)
1. Title 20 – Public Utilities and Energy
 2. Title 24 – California Building Standards Code
 - a. Part 1 – California Administrative Code
 - b. Part 6 – California Energy Code
- C. California Energy Commission (CEC)
1. Building Energy Efficiency Standards – Title 24 Parts 1 and 6
 2. Department of Energy (DOE) Determination: The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 90.1
- D. DesignLights Consortium (DLC)
1. Product Qualifications Criteria
 2. Qualified Products List
- E. Environmental Protection Agency (EPA)
1. Energy Star for Luminaires Version 2.0
- F. Federal Communications Commission (FCC)
1. Code of Federal Regulations (CFR), Title 47- Telecommunication, Part 15 – Radio Frequency Devices
- G. Illuminating Engineering Society of North America (IESNA)
1. ANSI/IESNA LM-63-02 – ANSI Approved Standard File Format for the Electronic Transfer of Photometric Data and Related Information
 2. National Electrical Contractors Association (NECA)/IESNA 500 – Standard for Installing Indoor Lighting Systems
- H. Institute of Electrical and Electronics Engineers (IEEE)
1. IEEE C62.41.2 – IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits
 2. IEEE 1789 – IEEE Recommended Practices for Modulating Current in High-Brightness LEDs for Mitigating Health Risks to Viewers
- I. International Electrotechnical Commission (IEC)
1. IEC 61000-4-2 – Electromagnetic Compatibility (EMC) – Part 4-2: Testing and Measurement Techniques – Electrostatic Discharge Immunity Test
- J. National Electrical Manufacturers Association (NEMA)
1. 410 – Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts

2. LE 4 – Recessed Luminaires, Ceiling Compatibility
 3. SSL 1 – Electronic Drivers for LED Devices, Arrays, or Systems
- K. National Fire Protection Association (NFPA)
1. NFPA 70® – National Electrical Code®
 2. NFPA 101® – Life Safety Code®
- L. Underwriters Laboratories Inc. (UL)
1. UL 508A – Standard for Industrial Control Panels
 2. UL 916 – Standard for Energy Management Equipment
 3. UL 924 – Standard for Emergency Lighting and Power Equipment
 4. UL 935 – Standard for Fluorescent-Lamp Ballasts
 5. UL 1310 – Standard for Class 2 Power Units
 6. UL 1598 – Luminaires
 7. UL 1598C – Standard for Light-Emitting Diode (LED) Retrofit Luminaire Conversion Kits
 8. UL 8750 – Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
1. Company with not less than ten years of experience manufacturing luminaires, dimming ballasts, dimming drivers, and lighting control systems.
 2. ISO 9001 certification, including in-house engineering for product design activities.
 3. Manufacturing facility employing electrostatic discharge reduction practices in compliance with ANSI/ESD S20.20 or equivalent.

1.06 DELIVERY, STORAGE, AND PROTECTION

- A. Receive, handle, and store products according to NECA/IESNA 500 and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.07 SPARE PARTS AND MAINTENANCE

- A. All spares shall be delivered in manufacturer's packaging suitable for protection from damage during long-term storage.
- B. Lenses and Louvers: 5% of total quantity but not less than one of each type provided.
- C. Extra Lamps: 10% of total quantity but not less than one of each type provided.

- D. Extra Ballasts or External Drivers: 5% of total quantity but not less than one of each type provided.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All lighting fixtures shall be in accordance with the National Electrical Code (NEC) and shall be constructed in accordance with the latest edition of the applicable Underwriters Laboratories Inc. (UL) standards. All lighting fixtures shall be UL labeled.
- B. Ballasts, drivers, and lamps shall comply with the requirements of the National Energy Policy Act of 2005.
- C. Provide products listed and classified by UL as suitable for the purpose specified and indicated.
 - 1. Provide products that are listed and labeled as complying with UL 1598, where applicable.
 - 2. LED Luminaire Components: UL 8750 recognized or listed as applicable.
- D. All devices shall comply with FCC requirements as listed in CFR, Title 47, Part 15 for commercial applications.
- E. All LED products shall bear the LED Lighting Facts label.
- F. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings, and other components required to position, energize, and protect the lamp and distribute the light.
- G. Provide all ancillary hardware required including conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.
- H. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc. for the location and service specified and shown on the Drawings.
- I. Recessed Luminaires:
 - 1. Ceiling Compatibility: Comply with NEMA LE 4.
 - 2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC rated, suitable for direct contact with insulation and combustible materials.
- J. Emergency Power Supply Units: Suitable for use with indicated luminaires, complying with NFPA 101 and applicable state and local codes, listed and labeled as complying with UL 924.
- K. Ballasts, drivers, lamps, and controls shall comply with applicable portions of the California Code of Regulations (CCR) Titles 20 and 24.
- L. All lighting control panels shall utilize UL-listed components and shall be manufactured and assembled in accordance with UL Standard 508A.

2.02 MATERIALS

A. Lighting Fixtures

- 1. Lighting fixture types shall be furnished as required by the Lighting Fixtures descriptions in Appendix 26 50 00-A. The catalog numbers are given as a guide to the design and quality of fixture desired. Equivalent designs proven with reviewed and approved calculations and equal quality fixtures of other manufacturers will be acceptable upon approval by the Engineer.
- 2. All LED fixtures and luminaires shall be listed on the DesignLights Consortium (DLC) Qualified Products List.
- 3. Where fixtures are to be installed recessed, verify the type of ceiling or wall construction, and provide the appropriate frames, mounting devices, and hardware.

B. Lamps

- 1. Light-Emitting Diode (LED) Lamps
 - a. Lamps shall meet ANSI C78.377.
 - b. Initial LED Lumen Output: 100% rated lumen output as specified on the Drawings
 - c. Light Output Depreciation Category: Category 1, Initial at 90%, 25% rated life
 - d. Failure Fraction: F10 (10%)
 - e. Color Temperature:

Correlated Color Temperature (CCT) Per ANSI C78.377	
Nominal CCT (K)	Allowable Tolerance (K)
2700	2725±145
3000	3045±175
3500	3465±245
4000	3985±275
4500	4503±243
5000	5028±283
5700	5665±355
6500	6530±510

- f. Minimum Color Rendering Index Value: 80
- g. Maximum Color Rendering Index Value Shift: 10%
- h. Power Factor: 85% minimum
- i. Indoor Fixture Ambient Operating Temperature Rating/Range: 25 °C / 0 °C to 40 °C
- j. Outdoor Fixture Ambient Operating Temperature Rating / Range: 15 °C / -15 °C to 40 °C
- k. LED lamps shall be manufactured by Cree, Samsung, Nichia Corporation, or equal.

2. Fluorescent Lamps
 - a. Lamps shall meet ANSI C82.11.
 - b. Lamps shall be 4100 Kelvin correlated color temperature (CCT).
 - c. Unless specifically noted otherwise on the Lighting Fixtures descriptions, all lamps shall be 265 mA, T8, instant start, and medium bi-pin. Length and wattage shall be as shown on the Lighting Fixtures descriptions.
 - d. All fluorescent lamps shall be of one manufacturer and shall be as manufactured by Sylvania, General Electric Company, Philips, or approved equal.

C. LED Fixture Drivers

1. Provide constant-current or constant-voltage drivers compatible with the selected fixture rated for operations for a minimum of 50,000 hours at maximum case temperature and 90% non-condensing relative humidity.
2. Provide thermal protection with automatic power output reduction to protect LED driver and LED light engine/fixture from damage due to over-temperature conditions. Reduction shall be applied when temperatures approach or exceed the LED driver's maximum operating temperature at calibration point.
3. Protective Features
 - a. Designed and tested to withstand electrostatic discharges without impairment when tested according to IEC 61000-4-2 or equivalent.
 - b. Designed and tested to withstand Category A surges of 4,000 V according to IEEE C62.41.2 without impairment of performance.
 - c. Meet NEMA 410 inrush requirements for mitigating inrush currents with solid-state lighting sources.
 - d. Employ integral fault protection and overvoltage protection up to 277 V for constant-voltage type; provide short-circuit, open-circuit, and overload protection for constant-current type.
4. UL Type TL-rated or UL Class P listed where specified. Suitable for field replacement as applicable; listed in accordance with UL 1598C or UL 8750; Class P where specified.
5. Class A Sound Rating: Inaudible in a 27 decibels (dBA) maximum ambient.
6. No visible change in light output under a variation of plus or minus 10% change in line-voltage input.
7. Provide LED drivers designed to evenly track across multiple fixtures of the same family or series at all light levels. UL Class 2 output suitable for hot swap of LED lamps.
8. 3-Wire Control: Provide integral control circuitry where specified. Control operation shall be from input voltage of 120 V through 277 V at 50/60 Hz.
9. Dimming type where specified in the Lighting Fixtures descriptions. Provide dimming range 100% to 1% measured output current unless otherwise specified. Provide pulse width modulation (PWM) output dimming frequency meeting IEEE 1789 requirements or constant-current reduction method.
10. Paired with LEDs and rated at least 20% greater than the maximum wattage rating of the driven fixture.

11. Meet requirements for solid-state devices for power factor, transient protection, power consumption, start time, and operating frequency per Energy Star Luminaires. Total harmonic distortion less than 20% at maximum power.

D. Ballasts

1. Unless otherwise indicated in the Lighting Fixtures descriptions, fluorescent ballasts shall be electronic, 25 kHz or higher, full-output, rapid-start type for use on 265 mA, T8 lamps.
 - a. All ballasts shall be UL listed, ETL certified, Class P, high power factor.
 - b. Ballasts shall have an A sound rating or better.
 - c. All ballasts used in exterior applications shall have a minimum starting temperature of 0 degrees F unless otherwise specified.
 - d. All interior ballasts shall have a minimum starting temperature of 50 degrees F.
 - e. Ballasts shall be series-wired type and designed to operate the number and length of lamps specified.
 - f. The total harmonic distortion (THD) of each ballast shall in no case exceed 10% THD.
 - g. Ballasts shall have a minimum ballast factor of 0.95.
 - h. Ballasts shall have nominal power factor 0.99 or higher.
 - i. Ballasts shall have a maximum lamp current crest factor of 1.5.
 - j. Ballasts shall provide normal rated life for the lamp specified.
 - k. Electronic ballasts shall be Osram, Electronic Ballast Technology, or approved equal.
2. High pressure sodium (HPS) ballasts shall be of the constant-wattage type of the correct size and voltage for the fixture it is to serve as shown on the Lighting Fixtures descriptions. All ballasts shall be manufactured by Holophane, Magnetek, or approved equal.
3. Metal halide ballasts shall be of the constant-voltage auto-transformer type of the correct size and voltage for the fixture it is to serve as shown on the Lighting Fixtures descriptions. All ballasts shall be manufactured by Holophane, MagneTek, or approved equal.

- E. Flexible Fixture Hangers: Flexible fixture hangers used in non-hazardous areas shall be type ARB and flexible fixture supports used in hazardous areas shall be type ECHF as manufactured by Crouse-Hinds (Eaton), Appleton (Emerson), Killark (Hubbell), or approved equal.

F. Emergency Lighting Battery Units

1. Emergency lighting units and remote lighting heads shall be as specified in the Lighting Fixtures descriptions and as shown on the Drawings.
2. Provide units conforming to UL 924.
3. Battery units shall be of the self-contained, full- automatic type with sealed lead-acid batteries, voltmeters and time delay relays where used in high-intensity discharge (HID) lighted areas. Batteries shall be sized to provide 90 minutes minimum of lighting.

4. Unit enclosures shall be compatible with their environment.
 5. All necessary mounting hardware shall be provided.
- G. Emergency Exit Lighting and Signage
1. Emergency exit lighting and signage shall be installed at designated locations shown on Drawings.
 2. Emergency lighting fixtures in process and industrial areas shall be self-powered units with corrosion-resistant enclosures rated NEMA 4X, temperature compensated, sealed 12-volt maintenance-free nickel-cadmium (NiCad) batteries, high-intensity incandescent light source, battery charger with LED indicator light, sealed push-to-test switch, and time delay.
 3. Emergency exit signs for non-process or non-industrial areas shall be similar, except with NEMA 1 enclosures.
 4. Provide units conforming to UL 924.
 5. Emergency exit signs shall utilize LED-style lights for illumination.

2.03 LIGHTING CONTROL PANELS

- A. General
1. Lighting control panels shall be provided where shown on the Drawings.
- B. In the REMOTE mode, the lighting controls receive a permissive to operate from a remote photocell to open and close a lighting contactor. The contactors shall be capable of being turned on and off manually by operating a HAND-OFF-REMOTE/HAND-OFF-AUTO control switch located on the panel front door. A remote system override also allows operators to turn the lights on and off remotely from the SCADA system as specified under Section 40 61 00.
- C. The panels shall be mounted as indicated on the Drawings. The number of contactors in the panels shall be as required to control the power to each load as indicated on the Drawings. Enclosures shall be rated NEMA 12 when mounted indoors and within NEMA 4X single door enclosures with provisions for padlocking when mounted outdoors. Panel identification nameplates and control device nameplates shall be mounted at the front of each panel.
- D. Control power shall be 120 V ac from an external power source as shown on the Drawings. Provide circuit breaker overcurrent protection for the incoming control power including Power On light. All power and control wiring shall be stranded 12 AWG minimum and shall be identified with a unique identification number. Provide terminal blocks rated 600 volts, 20 amperes minimum for connection of all external wiring. Terminal points shall be clearly and uniquely identified with fixture locations, zones, and other physical features consistent with the Drawings.
- E. Provide panel arc flash labels as required under Section 26 08 00.
- F. Lighting Contactors
1. Contactors shall be electrically operated by a dual-acting, single-solenoid mechanism that is inherently interlocked and mechanically held in both the open and closed positions. The main contacts shall be power driven in both directions. Positive locking of contact positions shall not be dependent on gravity, hooks, latches, or semi-permanent magnets.

2. Contactors shall be operable in any position. Provisions shall be incorporated for manual operation during inspection and maintenance.
3. Contactors shall be UL listed under UL 508A. Main contacts shall be double-break, continuous-duty rated 20 amperes to 600 volts ac, 60 hertz (30 amperes to 600 volts ac, 60 hertz, for general-purpose loads), and be marked for ballast lighting (electric discharge lamps). Lighting contactors requiring derating when used in an enclosure are not acceptable.
4. Contactors shall be provided with clamp-type, self-rising terminal plates for solderless connection of line, load, and control conductors. Terminals shall accept wire ranges from 18 AWG to 10 AWG copper.
5. The number of poles, up to a maximum of 12, on a single remotely controlled lighting contactor, shall be provided based on the number of fixtures controlled.
6. Contactors shall be UL listed for the following short-circuit withstand current ratings when coordinated with a UL listed molded case circuit breaker rated 30 amperes: 22,000 amperes RMS symmetrical.
7. The operating coil and main contacts shall be replaceable from the front without major disassembly and visual indication shall be provided for each contact.
8. Provisions shall be included to permit remote pilot-lamp type visual indications without the necessity for auxiliary contacts or additional wiring.
9. Acceptable Manufacturers:
 - a. ASCO 918 (Schneider Electric)
 - b. Eaton
 - c. GE (ABB)
 - d. Approved equal

G. Indicating Lights and Selector Switches

1. Provide heavy-duty, oil-tight type push-to-test indicating lights and selector switches. Devices shall meet the requirements of UL 508A, and have individual, legend plates indicating their specific function. Provide contacts with NEMA rating A600. Install provisions for locking selector switches in the OFF position.
2. Provide selector switches having standard operating levers. All indicating lights shall be full-voltage LED transformer, push-to-test type, with lens color as indicated on the Drawings.
3. Acceptable Manufacturers:
 - a. Eaton HT800 Series
 - b. GE (ABB) CR104P Series
 - c. Allen-Bradley Bulletin 800T/H
 - d. Approved equal

2.04 LIGHTING CONTROL DEVICES

A. Photocells

1. The photocells shall be suitable for power duty with individual fixtures or for pilot duty with contactors as detailed on the Drawings. Enclosures shall be NEMA 3R or 4. Contacts shall be rated for 1800 VA continuous at 120 volts. On-off light levels

shall be adjustable with adjustable delay of up to two minutes. Orient eye to the north. Adjust the unit to turn on at 1.5 footcandles and off at 5.5 footcandles with a 30-second delay.

2. Photocell shall operate on 120-volt power input.
3. Photocells shall be TORK Photocontrols (NSi Industries, LLC) or approved equal.

B. Exterior Motion Sensors

1. Provide fixture motion sensors suitable for exterior mounting as part of the pole-mounted fixtures. Provide exterior motion sensors as shown on the Drawings and per the Lighting Fixtures descriptions for installation as part of the pole-mounted fixtures. Provide UL listed switch suitable for wet locations rated for 120 V ac. Provide sensor compatible with relay pilot operation for control of groups of fixtures from a common control panel. Control scheme shall be as shown on the Drawings. Motion sensor shall have 360-degree detection pattern and adjustable time delay nominally from 5 seconds to 15 minutes.
2. Provide motion sensors as manufactured by RAB Lighting or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Each fixture shall be a finished unit with all components, mounting and/or hanging devices necessary for the proper installation of the specific fixture in its designated location and shall be completely wired ready for connection to the branch circuit wires at the outlet.
- B. Interior installations shall be in accordance with IESNA 500.
- C. Coordinate the installation of luminaires with mounting surfaces as shown on the Drawings. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
- D. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts provided under other sections.
- E. All flush-mounted fixtures shall be supported from the structure and shall not be dependent on the hung ceilings for their support.
- F. Install luminaires plumb and square, aligned with building lines and with adjacent luminaires. Provide extension rings to bring outlet boxes flush with finished services.
- G. Fixtures noted to be installed flush in suspended ceilings shall be of mounting types suited for the type of ceiling involved. It shall be the responsibility of the Contractor to verify the ceiling types prior to ordering fixtures. In addition to ceiling support wires, provide two dedicated galvanized fixture safety wires connecting the opposing corner of each recessed luminaire to the building structure.
- H. Flexible fixture hangers shall be used for all pendant-mounted fixtures. Fixtures two feet long and larger shall be supported with a minimum of two fixture hangers. Pendant fixtures shall be supported from rigid conduit. The use of threaded rods is not acceptable. Provide separate grounding conductor connected to a ground bushing or lug in the outlet box.

- I. Conduit run in areas with hung ceilings shall be installed in the space above the hung ceiling as close to the structure as possible. Conduits shall be supported from the structure.
- J. Fixture locations are shown on the Drawings in approximate locations; however exact locations shall be coordinated to avoid conflicts with heating ventilation and air conditioning (HVAC) ducts, HVAC equipment, piping, and any other obstacles or obstructions.
- K. Fixture mounting heights shown on the Drawings shall be as measured from the referenced finished surface to the bottom of the luminaire.
- L. Photocells shall be mounted facing north and in a location that is unaffected by light fixture sources.
- M. Motion sensors shall be mounted and configured to track motion in main egress locations or in areas as necessary for ensuring site security.

3.02 ADJUSTMENT

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by the Engineer. Adjust luminaires to avoid glare and light leakage to areas outside of the facility property lines.

3.03 STARTUP

- A. Operate each luminaire after installation to verify proper operation.
- B. Test emergency power supply units to verify proper operation upon loss of power. Replace drivers or ballasts that exceed the manufacturer's rated noise levels or that exceed project-specified noise limits.
- C. Protect installed luminaires from subsequent construction. Replace any damaged or failed lamps prior to substantial completion.
- D. All lamps used during construction, except for LED and high-intensity discharge (HID) lamps, shall be removed and replaced with new lamps two weeks from completion of the work.

3.04 CLEANING UP

- A. Plastic dust cover bags that are provided with new parabolic reflector lighting fixtures shall be removed after all construction activity that may cause dust formation on reflector surfaces has been completed.
- B. Clean surfaces according to IESNA 500 and manufacturer's instructions to remove dirt, fingerprints, paint, foreign spatter, or materials. Restore finishes to match original factory finish. All fixtures shall be left in a clean condition, free of dirt and defects, before acceptance by the Engineer.

END OF SECTION

APPENDIX 26 50 00-A

LIGHTING FIXTURES

Note: Fixture letter designations used in this Appendix are referenced on the Drawings. The manufacturer and part numbers listed are intended as a guide to the Contractor and are not intended to preclude selection and use of equivalent fixtures made by an alternative manufacturer.

SECTION 31 05 13 – CLEARING & GRUBBING, EXCAVATION, AND EARTHWORK**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Clearing and Grubbing
2. Excavation
3. Earthwork
4. Grading and Compaction
5. Subsoil materials – Import Fill and Select Fill
6. Topsoil materials.

B. Related Sections:

1. [Section 01 74 00 – Construction Waste Management and Disposal](#)
2. [Section 31 23 16 – Utility Trenching.](#)
3. [Section 32 90 00 – Landscape Work.](#)
4. Project Geotechnical report; bore hole locations and findings of subsurface materials if applicable.

1.2 UNIT PRICES - MEASUREMENT AND PAYMENT

A. Clearing and Grubbing:

1. Basis of Measurement: Clearing and grubbing will be measured on a lump sum basis, unless specified otherwise.
2. Basis of Payment: Clearing and grubbing shall be paid for at the contract lump sum price, which includes full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all work involved in clearing and grubbing as shown on the plans, as specified and as directed by the Project Manager, including the removal and disposal of all the resulting material.
 - a. When the Contract does not include a pay item for Clearing and Grubbing and removal work, as specified above, and unless noted otherwise in the Technical Specifications, full compensation for any necessary Clearing and Grubbing and removal work shall be considered as included in the unit price paid for the type of earthwork involved, and no additional compensation will be allowed therefor.

B. Subsoil – Select Fill

1. Basis of Measurement: By cubic yard of the compacted soil.

2. Basis of Payment: Includes excavating existing subsoil, verifying if existing subsoil meets the select fill requirements, supplying select fill, materials, stockpiling, maintaining, moving, placing and compacting of select fills.

C. Subsoil – Import Fill

1. Basis of Measurement: By cubic yard of the compacted soil.
2. Basis of Payment: Includes excavating, importing, supplying import fill subsoil materials, stockpiling, surveying stockpile location, maintaining, moving, placing and compacting of import fill.

D. Subsoil – Export Fill

1. Basis of Measurement: By cubic yard of the compacted soil.
2. Basis of Payment: Includes excavating, stockpiling, covering, maintaining, moving, exporting cut subsoil materials, compacting of cut soil at the export location, and all other work described in this section, and as shown on the Drawings.

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. City of Pittsburg - Environmental Services Department

C. ASTM International:

1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³).
2. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³).
3. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

D. California Building Code – Appendix J - Grading

E. State Standard Specifications:

1. Section 14 – Environmental Stewardship
2. Section 17 - General
3. Section 19 – Earthwork

1.4 SUBMITTALS

- A. [Section 01 33 00 - Submittal Procedures](#): Requirements for submittals.
- B. Samples: Submit results of the soil samples by a certified testing laboratory prior to importing onto the site for approval by the Project Manager.
- C. Materials Source: Submit name of imported materials source.
- D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

- A. Furnish each subsoil material from single source throughout the Work.

PART 2 - PRODUCTS

2.1 SUSTAINABILITY CHARACTERISTICS

- A. Materials and Resources Characteristics:
 - 1. Regional Materials: Furnish materials extracted, processed, and manufactured within 250 miles of jobsite.

2.2 SUBSOIL MATERIALS

- A. Select Fill Material:
 - 1. Subsoil material is on-site excavated material meeting the requirements of the appurtenant Geotechnical Report.
 - 2. Graded
 - 3. Non-hazardous
 - 4. Free of lumps larger than three (3) inches, rocks larger than two (2) inches, organic matter, frozen or other deleterious materials and debris.
 - 5. Selected material encountered in excavation within the right of way shall be used for finishing the top portion of the roadbed, constructing shoulders, structure backfill; as shown on the Drawings; as specified in the Technical Specifications, or as directed by the Project Manager.
- B. Import Fill Material:
 - 1. Subsoil material imported from sources outside the project site meeting the requirements of the appurtenant Geotechnical Report.

2. Graded
3. Non-hazardous
4. Free of lumps larger than three (3) inches, rocks larger than two (2) inches, organic matter, frozen or other deleterious materials and debris.
5. Unless otherwise specified, the Contractor shall obtain from the owners the right to procure material, pay all royalties and other charges involved, and bear all expense of developing the sources, including rights of way for hauling.
6. No import fill material shall be delivered to the site until approved by the Project Manager. Approval of import fill material shall be based on the testing of representative samples submitted by the contractor meeting the appurtenant Geotechnical Report and approved by the Project Manager. Such representative samples shall be submitted to the Project Manager not less than 15 days prior to commencing the work.
7. Imported fill, delivered to the site, that significantly differs from the submitted samples shall be subject to rejection. Rejected materials shall be removed from the site at the Contractor's expense
8. Approval of a particular import fill material shall constitute approval of only that portion of the proposed borrow source represented by the submitted sample.
10. Except as otherwise permitted, borrow pits and other excavation areas shall be excavated in such manner as will afford adequate drainage. Overburden and other spoil material shall be transported to designated spoil areas or otherwise disposed of as directed, local borrow pits shall be neatly trimmed and left in such shape as will facilitate accurate measurement after the excavation is completed.

2.3 FILL MATERIALS:

The following import fill parameters may be used for small City sidewalk and pavement rehabilitation projects; or for site improvements less than 5,000 square feet excluding any buildings or structures and do not have a geotechnical report included:

- A. Fill material shall conform to the following as determined by ASTM C 117 and ASTM C 136:
 1. Maximum particle size 3 inches
 2. Percent passing 1-inch sieve 90-100 percent
 3. Percent passing No. 200 sieve less than 20 percent
- B. Imported non-expansive fill shall consist of a well-graded, slightly cohesive soil with relatively impervious characteristics when compacted.
- C. Plasticity Index for acceptable import fill materials shall be a maximum of 15 when determined by the procedure set forth in ASTM D 4318.

- D. The liquid limit shall not exceed 40 percent as determined by the procedures set forth in ASTM D 4318.
- E. Import fill material shall have an R-value of 25 or greater as determined by ASTM D 2844.

2.4 TOPSOIL MATERIALS

- A. Topsoil shall be imported top soil as specified in [Section 32 90 00 "Landscape Work"](#) and Project Specifications.
- B. Topsoil excavated within the limits of the project meeting the requirements shown in Section 32 90 00, "Landscape Work", and as shown in the Project Specifications will be considered as a material only for the purpose of backfilling areas to be planted.

2.5 SOURCE QUALITY CONTROL

- A. [Section 01 45 00 – Quality Control](#): Testing and Inspection Services Testing and analysis of soil material.
- B. Testing and Analysis of Subsoil and Topsoil Materials: Perform in accordance with ASTM D698, ASTM D1557, and AASHTO T180.
- C. When tests indicate materials do not meet specified requirements, provide alternate materials and retest.
- D. Furnish materials of each type from same source throughout the Work.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Call USA not less than three (3) working days before performing Work that can be marked by USA in a timely manner.
- B. Request underground utilities to be located and marked within and surrounding construction areas.
- C. Identify required lines, levels, contours and datum.
- D. Notify utility companies to remove and relocate utilities where shown on the Drawings.
- E. Protect utilities indicated to remain from damage.

- F. Protect plant life, lawns, and other features remaining as portion of final landscaping.
- G. Protect benchmarks or monuments, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.
- H. The ground shall be prepared to received select fill by removing vegetation, topsoil and other unsuitable materials, scarifying the ground to provide a bond with the fill material, and compacting the fill at optimum moisture content.

3.2 CLEARING AND GRUBBING

- A. Clearing and grubbing shall be per Section 17-2, "Clearing and Grubbing", of the State Standard Specifications.
- B. Clear and grub before performing earthwork in an area.
- C. Do not injure standing trees, plants, and improvements shown to be protected.
- D. Clear and grub the entire length of the job site to the following widths:
 - 1. 5 feet outside of excavation and embankment slope lines where slopes are not rounded
 - 2. Outside limits of slopes where slopes are rounded
 - 3. 5 feet outside of structures
 - 4. 2 feet outside of slope lines for ditches and channels with a bottom width of less than 12 feet
 - 5. 5 feet outside of slope lines for ditches and channels with a bottom width of 12 feet or more
- E. Clearing and grubbing shall consist of removing all objectionable material from within the limits of the project. The limits of clearing and grubbing shall be of sufficient area and depth to complete the work shown on the Drawings or as described herein in.
- F. Clear all construction areas above original ground of the following to a minimum depth of eight (8) inches below subgrade or eight (8) inches below original ground, or as required by the appurtenant geotechnical report, whichever is lower:
 - 1. all vegetation such as trees, logs, upturned stumps, roots of downed trees, brush, grass, and weeds and
 - 2. other objectionable material including concrete, masonry, and debris.
- G. No burning of materials is allowed.
- H. The site shall be stripped and cleared of all vegetation, debris, and organic-laden top soil as required by the appurtenant Geotechnical Report.

- I. Trees within the limits of work including any traffic control work beyond the limits of work and within the area of influence shall be evaluated by the City or; a City approved Landscape Architect or certified Arborist to assess protection measures. No trees will be removed until they have been tagged, numbered and a written release for the tree has been issued by the City.
- J. Tree which are designated to be removed, shall be excavated and removed 30" down to remove the tree trunk, roots, and backfill with fill material and compact as required in this section, unless specified otherwise on the Drawings.
- K. Grub all construction areas to a depth of at least 0.50 feet, necessary to remove all existing tree stumps, roots, buried logs and other objectionable material, unless noted otherwise on the Plans. In embankment areas where the grading plane is 2 feet or more above original ground, cut off trees, stumps, and roots not more than 1 foot above original ground, except, remove trees, stumps, and roots completely where work includes any of the following:
 - 1. Structure construction
 - 2. Pile construction
 - 3. Subdrainage trench excavation
 - 4. Removal of unsuitable material
 - 5. Cutting into slopes of original hillsides, old or new fill
 - 6. Utility line construction

3.3 EXCAVATION

- A. Work under this section shall consist of performing all operations necessary to excavate earth and rock, regardless of character and subsurface conditions, from the roadway prism or adjacent thereto, to excavate all materials, of whatever nature, necessary for the construction of foundations for structures and other facilities; to excavate drainage and irrigation ditches; to excavate drainage channels; to excavate selected material and import material for use as specified; to construct embankments including the placing of selected fill or import fill material in connection therewith as specified; to place backfill for structures, and other facilities; to backfill trenches and depressions resulting from the removal of obstructions; to backfill holes, pits and other depressions; to remove and replace unsuitable material; to excavate and grade road approaches, driveways, sidewalks, curb ramps, curb and gutters, plazas, parking lots, and connections; to construct protection dikes; to remove unstable material, slide material which has come into the graded area, and material which has slipped from embankments; all as shown on the plans and as specified in these Specifications and the Technical Specifications and as directed by the Project Manager; and furnishing all labor, materials, tools, equipment and incidentals, and for doing all the work that may be required to construct and maintain the project facilities, except excavation, trenching and backfilling for pipe, culverts, utility systems, and other subsurface pipes. Excavation, trenching and backfilling for pipe, culverts,

utility systems, and other subsurface pipes is specified in [Section 31 23 16 – Utility Trenching](#) of the City Standard Specifications.

- B. Excavate subsoil and topsoil from areas designated. Strip topsoil to full depth of topsoil in designated areas.
- C. Stockpile excavated material meeting requirements for subsoil fill materials and topsoil materials approved by the Project Manager.
- D. If practicable and unless processing of material is required, haul selected material directly from the excavation to its final position in the roadway prism and compact it in place.
- E. Excavate to the described or authorized grade. If the Contractor over excavates, backfill with an authorized material and compact it at the Contractor's own expense.
- F. Do not excavate wet subsoil unless directed by the Project Manager.
- G. The temporary slope of cut surfaces shall be no steeper than is safe for the intended use, and shall not be more than one-unit vertical in two units horizontal (50-percent slope) unless approved by the Project Manager or appurtenant geotechnical report.
- H. Archaeological Resources: Contractor shall conform to Section 14, "Environmental Stewardship", of the State Standard Specifications. If archaeological resources are discovered within or near construction limits, do not disturb the resources and immediately:
 - 1. Stop all work within a 60-foot radius of the discovery
 - 2. Secure the area
 - 3. Notify the Project Manager.
- I. City will investigate the discovery. Do not move archaeological resources or take them from the job site. Do not resume work within the radius of discovery until authorized.
- J. Environmentally Sensitive Areas (ESA): If an ESA is shown on the Drawings, the boundaries are approximate. Do not enter an ESA unless authorized. If an ESA is breached, immediately:
 - 1. Stop all the work within 60 feet of the ESA boundary
 - 2. Secure the area
 - 3. Notify the Project Manager

If an ESA is damaged, the Project Manager determines the necessary remediation and the party to perform the work. The City deducts the cost for this work from the Contractor bid price.

- K. Notify the Project Manager when buried man-made objects are encountered in an excavation as part of the excavation work and wait for direction from Project Manager unless shown on the plans for removal. All surplus material shall be disposed offsite.
- L. Remove excess excavated materials, subsoil and topsoil not intended for reuse, from site.
- M. Remove excavated materials not meeting requirements for subsoil materials and topsoil materials from site.
- N. When hauling is done over highways or City streets, and when directed by the Project Manager the loads shall be trimmed and all material removed from shelf areas of vehicles in order to eliminate spilling of material. If directed by the Project Manager, the loads shall be watered down or covered after trimming to eliminate dust.
- O. Excavation shall include the satisfactory removal and disposition of all materials not classified as rock excavation.
- P. Earth and rock, regardless of character and subsurface conditions, shall be excavated to the lines and grades as established by the plans.
- Q. All existing materials that are designated to be salvaged shall be removed, cleaned and hauled to the City Corporation Yard, unloaded and stockpiled, by the Contractor unless otherwise directed by the Project Manager.
- R. Existing pipes to be abandoned shall be filled with slurry, minimum of thirty (30) feet from either ends of the pipe and capped with concrete at the ends.
- S. Existing structures, pavement slabs, and structural sections to be abandoned shall be demolished to an elevation three (3) feet below finished grade, unless specified otherwise on the Drawings. The bottom (if any remains) shall be broken thoroughly to prevent entrapment of water and all voids backfilled with suitable backfill.
- T. Operations shall be conducted in such a manner that existing street, facilities, utilities, railroad tracks and other non-street facilities which are to remain in place will not be damaged.
- U. The Contractor, at his expense, shall furnish and install-sheet piling, cribbing, bulkheads, shores or whatever means may be necessary to adequately support material carrying such facilities, or to support the facilities themselves, and shall maintain such supports until they are no longer needed. Temporary pavements, facilities, utilities and installations shall also be protected until they are no longer required. When temporary supports and other protective means are no longer

required, they shall become the property of the Contractor and shall be removed and disposed of from the job site

- V. Prior to placing import fill material, all areas to receive fill shall be scarified and compacted. Unless otherwise stated in the appurtenant Geotechnical report, the area shall be scarified to a minimum of eight (8) inches, material shall be moisture conditioned by wetting or drying to optimum moisture content, and compacted.

3.4 ROCK EXCAVATION

- A. Rock excavation shall include excavating, grading, and disposing of materials classified as rock and shall include the satisfactory removal and disposition of rock 1/2 cubic yard or more in volume.
- B. No blasting is allowed.

3.5 GRADING

- A. Grading shall consist of placing fill materials on site to contours and elevations with select fill or import fill materials.
- B. Place fill material in continuous layers of maximum lifts of 8 inches (0.67 feet) and compact in accordance with schedule shown in this section, unless otherwise shown on the appurtenant Geotechnical Report.
- C. Maintain optimum moisture content of fill materials to attain required compaction density.
- D. Construct slopes to the lines and grades shown on the Drawings.
- E. Slope grade away from the building minimum 2% slope for a minimum distance of 10 feet, unless noted otherwise.
- F. Make grade changes gradual. Blend slopes into level areas.
- G. Round the tops of excavation slopes and ends of excavation.
- H. Maintain completed slopes. Repair any slopes damaged by erosion.
- I. Repair or replace items indicated to remain that are damaged by excavation or filling.
- J. Identify any site low points which need positive drainage and make adjustments with approval from Project Manager prior to pouring concrete.

- K. Protection of existing slopes using erosion control measures as required in [Section 01 57 23 – Storm Water Pollution Prevention](#).

3.6 TOLERANCES

- A. [Section 01 45 00 – Quality Control](#): Tolerances.
- B. Immediately before placing subsequent layers of material, prepare the grading plane such that the grading plane:
 1. Does not vary more than 0.05 foot above or below the grade established by the Engineer where Hot Mix Asphalt (HMA) or aggregate base are to be placed.
 2. Does not extend above the grade established by the Engineer where concrete base or pavement is to be placed.
 3. Beneath structural approach slabs or the thickened portion of sleeper slabs do not extend above the grade established by the Engineer.
 4. At any point is within 0.05 foot above the grade established by the Engineer if the material to be placed on the grading plane is paid by the cubic yard.

3.7 COMPACTION

- A. Relative compaction specifications apply to material whether in an excavation or an embankment.
- B. The moisture content of material to be compacted to at least 95 percent must be such that the specified relative compaction is attained, unless specified otherwise in the appurtenant Geotechnical Report.
- C. Compact earthwork to a relative compaction of at least 95 percent for at least a depth of:
 1. 0.5 foot below the grading plane for the width between the outer edges of shoulders
 2. 2.5 feet below the finished grade for the width of the traveled way including any parking lots or other vehicular areas; to extend plus two (2) feet on each side.
- D. All fill material shall be compacted to at least 90 percent of maximum density as determined by ASTM D1557, Modified Proctor, beyond the depth specified above in 3.7.C, unless otherwise shown in the appurtenant Geotechnical Report.

3.8 STOCKPILING

- A. Stockpile materials on site at locations indicated on the plans or as designated by Project Manager.

- B. Stockpile in sufficient quantities to meet Project schedule and requirements.
- C. Separate differing materials with dividers or stockpile apart to prevent mixing.
- D. Prevent intermixing of soil types or contamination.
- E. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.
- F. Stockpile unsuitable or hazardous materials on impervious material and cover to prevent erosion and leaching, until disposed of. Dispose unsuitable or hazardous material within 48 hours of removal.

3.9 STOCKPILE CLEANUP

- A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.
- B. Leave unused materials in neat, compact stockpile.
- C. When borrow area is indicated, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

3.10 PROTECTION

- A. Prevent displacement or loose soil from falling into excavation; maintain soil stability.
- B. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.
- C. Protect structures, utilities, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth operations.

END OF SECTION 31 05 13

SECTION 31 05 14 – SUBGRADE ENHANCEMENT GEOSYNTHETIC

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Subgrade Enhancement Geogrid
 - 2. Subgrade Enhancement Geotextile.

- B. Related Sections:
 - 1. [Section 31 05 13 – Clearing & Grubbing, Excavation, and Earthwork](#)
 - 2. Project Geotechnical report (if available).

1.2 UNIT PRICES - MEASUREMENT AND PAYMENT

- A. Subgrade Enhancement Geogrid/Geotextile
 - 1. Basis of Measurement: By square yard measured parallel to the surface, not including the additional quantity used for overlaps.
 - 2. Basis of Payment: Includes furnishing, storing, maintaining, placing the subgrade enhancement geogrid/geotextile between the subgrade and the pavement structure or as shown on the Drawings.

1.3 REFERENCES

- A. State Standard Specifications:
 - 1. Section 19-10 – Subgrade Enhancement Geosynthetic
 - 2. Section 96 - Geosynthetics

1.4 SUBMITTALS

- A. [Section 01 33 00 - Submittal Procedures](#): Requirements for submittals.
- B. Samples: Submit samples of the geogrid when requested by the Project Manager.
- C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

PART 2 - PRODUCTS

2.1 SUBGRADE ENHANCEMENT GEOGRID

- A. Subgrade enhancement geogrid must be biaxial geogrid. Biaxial geogrid must conform to Section 96-1.02P- Biaxial Geogrid.
- B. Biaxial geogrid must be a punched and drawn polypropylene material formed into an integrally formed biaxial grid.

2.2 SUBGRADE ENHANCEMENT GEOTEXTILE

- A. Subgrade enhancement geotextile must be Class B2 as specified in Section 96-1.02O- Subgrade Enhancement geotextile, unless otherwise shown on the Drawings.
- B. A polyester geotextile must not be used for subgrade enhancement geotextile within four (4) inches of recycled concrete.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Before placing subgrade enhancement geogrid/geotextile, remove loose or extraneous material and sharp objects that may come in contact with the geosynthetic material.
- B. Place the geosynthetic:
 - 1. Under the manufacturer's instructions
 - 2. Longitudinally along the roadway alignment
 - 3. Without wrinkles.
- C. Overlap the adjacent edges of the rolls at least two (2) feet. Overlap the ends of rolls at least two (2) feet in the direction of spread covering the subgrade enhancement geosynthetic. Geogrid or Geotextile should be extended all the way to the gutter lip.
- D. Fold or cut the geosynthetic to conform to curves. Overlap any cut material at least two (2) feet. Hold the overlap in place with staples, pins, or small piles of material placed on the subgrade enhancement material.
- E. Make any repairs to the geogrid or geotextile material by placing a new piece of material over the damaged areas with at least three (3) feet of overlap from the edges of the damaged area.

- F. Compact the aggregate base with either a
 - 1. Smooth wheeled roller with no vibrations
 - 2. Rubber tire roller
- G. Do not stockpile material on the geosynthetic.
- H. Do not place any geosynthetic material that cannot be covered on the same day.
- I. Do not operate equipment or vehicles directly on geosynthetic material unless one of the following conditions are met:
 - 1. Vehicles and equipment are
 - a. Equipped with rubber tires
 - b. Operated under 10 miles per hour
 - c. Operated in a manner to avoid sudden braking and sharp turns
 - 2. At least 0.35 feet of aggregate base had been placed, spread, and compacted on the geogrid.
- J. Do not compact the subgrade geosynthetic material with a sheepsfoot or other non-smooth roller.
- K. Do not turn vehicles on material placed directly over geosynthetic material.
- L. Before operating equipment on areas where geosynthetic material has been placed, spread and compact 0.5 feet of material on the geosynthetic.

END OF SECTION 31 05 13

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SECTION 31 23 16 – UTILITY TRENCHING**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. The work of this Section includes all saw cutting, utility trenching, earthwork and removal of surface material as required for construction of the utility trenches. Such earthwork shall include, but may not necessarily be limited to, the loosening, removing, loading, transporting, depositing, and compacting in its final location of all materials wet and dry, as required for the purposes of completing the work, which shall include, but not necessarily be limited to, the furnishing, placing, and removing of sheeting, shoring and bracing necessary to safely support the sides of all excavations; all pumping, ditching, draining and other required measures for the removal or exclusion of water from the excavation; the supporting of structures above and below the ground; all backfilling around structures and all backfilling of trenches and pits; restoration of surface, pavement markings, the disposal of excess excavated materials; borrow of materials to make up deficiencies for fills; and all other incidental earthwork.
2. All utility lines not owned by the City shall be designed and constructed in accordance with the rules and regulations of serving utilities. All utilities shall be installed prior to placement of the wearing surface of the street. It shall be the responsibility of the Contractor to conform to these provisions.
3. All broken concrete, pavement, base and other material and unsuitable and surplus excavated material shall be removed, hauled off the site and disposed of by the Contractor at a location obtained by the Contractor and approved by the Project Manager all at no additional cost to the City; said costs and fees shall be considered as included in the prices bid.
4. All materials regardless of character and subsurface conditions shall be excavated to the depths indicated or specified. During excavation, suitable trench material that will be used as backfill shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins, or shall be separately stockpiled. All excavated materials not required or unsuitable for backfill shall be disposed of outside the Right-of-Way as specified in Section 5-1.20B(4) "Contractor–Property Owner Agreement" of the State Standard Specifications

5. All hazardous materials shall be handled in accordance with all regulatory agency requirements and as specified in Section 14-11.03, "Hazardous Waste Management", of the State Standard Specifications. Contractor-generated hazardous waste shall be disposed of outside the Right-of-Way as specified in Section 14-11.06B, "Contractor-Generated Contaminated Soil", of the State Standard Specifications. Within 5 business days of transporting hazardous waste, submit documentation of proper disposal from the receiving landfill.
6. Where there is not a specific bid item for Hazardous Waste Management, full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in handling of the hazardous waste shall be considered included in the price paid for various items of work and no separate compensation will be allowed therefor.
7. All surface openings shall be saw cut using a power-driven saw with a diamond blade to provide a smooth joint for both concrete and bituminous street and sidewalk surfaces. All the trenches shall be "T" cut trenches as per City Standard details.
8. Impact pavement breakers (drop hammers, stampers, jack hammers) are not permissible.
9. The requirements of Section 7-1.02K(6) and 7-1.02L(2) of State Standard Specifications concerning Trench Safety and Antitrust Claims shall be complied with in addition to the requirements of Article 6 and Section 1503 of the State of California Construction Safety Orders.
10. Grading shall be done as may be necessary to prevent surface water from flowing into trenches or other excavations. Unless otherwise indicated, excavation shall be by open cut except that short sections of a trench may be tunneled if the pipe, cable, or duct can be safely and properly installed, backfilled with Controlled Low Strength Materials not tamped in such tunnel sections.

B. Related Sections:

1. [Section 01 33 00 - Submittal Procedures](#)
2. [Section 02 41 00 - Demolition](#)
3. [Section 31 05 13 – Clearing & Grubbing, Excavation, and Earthwork](#)
4. [Section 32 11 23 - Aggregate Base Courses](#)
5. [Section 32 12 16 - Asphalt Paving](#)
6. [Section 32 13 13 - Concrete Surface Improvements](#)
7. [Section 33 05 13 - Manholes and Structures](#)
8. [Section 33 11 13 - Water Distribution Piping](#)
9. [Section 33 12 13 – Water Service Connections](#)
10. [Section 33 31 13 - Sanitary Sewer Piping](#)
11. [Section 33 41 13 - Storm Drainage Piping](#)

C. California Codes:

1. Titles 17 and 22 California Code of Regulations - Chapter 16 – California Waterworks Standards
2. Water Main Separation Criteria: Chapter 16 - California Waterworks Standards Article 6 - §64572

1.2 UNIT PRICE - MEASUREMENT AND PAYMENT (For City CIP Projects only)

A. Utility Trenching and Earthwork:

1. Measurement: Utility Trenching is typically not a measured item. However, when a bid item is included for Utility Trenching or Joint Utilities Trenching, measurement, unless otherwise designated, shall be the number of linear feet of longitudinal trench centerline, measured along the design slope of the trench bottom, to the nearest foot to the conduit end, pay line, or outside face of connecting structure as designated. Any trenching or excavation for connecting structures shall be included in the measurement for the structure.
2. Payment: Unless there is a separate bid item, full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in Utility Trenching, complete in place including saw cut, excavating to required elevations, protecting the excavation in compliance with Cal/OSHA, removing and disposing of excavated materials, removing and disposing of any asphalt paving mats or fabrics, stockpiling excavated materials, dewatering, bedding, backfill, removing trench sheathing, shoring and bracing when no longer required, restoration and disposing of materials outside the Right-of-Way shall be considered as included in various items of work most closely related to and no separate compensation will be allowed therefor. Payment is not made for over excavated work nor for replacement materials, unless approved in writing by the Project Manager.

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International:

1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).

2. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
 3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³).
 4. ASTM D1633 - Standard Test Methods for Compressive Strength of Molded Soil-Cement Cylinders.
 5. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
 6. ASTM D2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
 7. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
 8. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
 9. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
 10. ASTM D3776 - Standard Test Methods for Mass Per Unit Area (Weight) of Fabric.
 11. ASTM D3786 - Standard Test Method for Bursting Strength of Textile Fabrics -Diaphragm Bursting Strength Tester Method
 12. ASTM D4253 - Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
 13. ASTM D4254 - Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
 14. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
 15. ASTM D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity
 16. ASTM D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
 17. ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile
 18. Cal/OSHA - Division of Occupational Safety and Health (DOSH) Administration
- C. State Codes;
- a. California Labor Code
 - b. Construction Safety Orders of the State of California
- D. State of California (Caltrans) - State Standard Specifications:
- a. Section 25 - Aggregate Subbases
 - b. Section 26 - Aggregate Bases

1.4 DEFINITIONS

- A. Utility: Any buried pipe, duct, conduit, or cable.
- B. Utility Structure: Maintenance holes, inlets, catch basins or vaults

1.5 SUBMITTALS

- A. [Section 01 33 00 - Submittal Procedures](#): Requirements for submittals.
- B. Excavation Protection Plan: Contractor's attention is directed to the provisions in Section 6705 of the California Labor Code. Prior to beginning any trench or structure excavation five (5) feet or more in depth, the Contractor shall submit to the Project Manager for review for compliance with Section 6705 of the Contractor's detailed excavation protection plan showing the design of all shoring, bracing, sloping of the sides of excavation, or other provisions to be made for worker protection from the hazard of caving ground during the excavation of such trenches or structure excavations.
- C. Product Data: Contractor shall submit data for various types of backfill, trenching and shoring plans, and geotextile fabric. Contractor shall submit laboratory results indicating all soils and backfill material are not hazardous.
- D. Samples: Contractor shall submit fill samples, in air-tight containers for each type of fill to testing laboratory.
- E. Materials Source: Contractor shall submit name of imported fill materials suppliers.
- F. Manufacturer's Certificate: Certificates of Compliance shall be provided for all products and materials proposed to be used under this Section.
- G. Contractor shall submit a Safety Certification

1.6 QUALITY ASSURANCE

- A. Capital Improvement Projects (CIP):
 - 1. All soil and backfill testing shall be done by a testing laboratory of the City's choice at the City's expense except as otherwise specified in Paragraph 1.6 B. below. The Contractor shall notify the Project Manager at least 48 hours prior to performing any utility excavation and before beginning of backfill materials.
 - 2. Where soil material is required to be compacted to a percentage of maximum density the maximum density at optimum moisture content will be determined in accordance with ASTM D 1557. Where cohesionless, free draining soil material is required to be densified to a percentage of relative

density the calculation of relative density will be determined in accordance with ASTM D 4253 and D 4254. Field density in-place tests will be performed in accordance with ASTM D 2922, or by such other means acceptable to the Project Manager.

3. In case the first test and one re-test of the fill or backfill show non-compliance with the requirements, the Contractor shall accomplish such remedy as may be required to insure compliance. Subsequent re-testing after the first re-test to show compliance shall be at the Contractor's expense.

- B. All Other Projects including but not limited to permit projects, utility company projects, development and redevelopment projects:
 1. All soil and backfill testing shall be by the Permittee/Developer/Utility Company's Geotechnical Engineer of Record and shall submit all testing information to the City.
 2. Maintain one copy of the Construction Documents and City Standard Details and Specifications on site.

1.7 QUALIFICATIONS

- A. If the Contractor's excavation protection plan varies from the shoring system standards established in the Construction Safety Orders of the State of California, such alternative system plan shall be prepared, stamped and signed by a Civil or Structural Engineer licensed in the State of California at the Contractor's expense.

1.8 FIELD MEASUREMENTS

- A. Contractor shall verify field measurements prior to fabrication.

1.9 COORDINATION

- A. Verify Work associated with lower elevation utilities is complete before placing higher elevation utilities.

PART 2 - PRODUCTS

2.1 SUITABLE FILL MATERIALS

- A. Suitable backfill shall be a selected or processed clean, fine earth, rock, or sand, free from objectionable materials, vegetation, or other deleterious substances.
- B. All import material from a source outside the project limits for use as backfill shall be clean soil, not hazardous, free from organic material, trash, debris, rubbish,

broken Portland cement concrete, bituminous materials or other objectionable materials. Whenever the Contractor elects to use imported material for backfill, it shall be delivered not less than 10 days prior to the intended use and a sample of the material shall be submitted to the Project Manager for review. The sample shall have a minimum dry weight of 100 pounds and shall be clearly identified as to source, including street address and community of origin. The Project Manager will determine the suitability, the minimum relative compaction to be attained, and the placement method. If the backfill material is found not suitable, the Contractor shall remove material from the site and dispose of at no additional cost to the City.

- C. Should the imported material not be substantially the same as the approved sample, it shall not be used for backfill and shall be removed from the job site at the Contractor's expense.
- D. The densification method for imported material authorized by the Project Manager will be dependent upon its composition, the composition of the in-place soil at the point of placement, once the relative compaction to be obtained.
- E. The following are the types of backfill materials:
 - 1. **Sand** shall be a material with 100 percent passing a 3/8" sieve, at least 90 percent passing a No. 4 sieve, and a sand equivalent value not less than 30.
 - 2. **Class 2 Aggregate Base** shall be crushed rock aggregate base material meeting the requirements of Section 26, "Aggregate Bases", for 3/4" maximum aggregate gradation, of the State Standard Specifications. Recycled Aggregate Base is an acceptable backfill material.
 - 3. **Controlled Low Strength Materials (CLSM)** shall be fluid workable mixture of cement, pozzolan, aggregate and water mixed in accordance with ASTM C94. Cement shall be Type II Cement and comply with ASTM C150. Pozzolan shall be added to improve the flowability and shall be Type F in accordance with the requirements of ASTM C618. Water must be free of oil, salts, and other impurities that adversely affect the backfill. Aggregate must consist of well graded mixture of crushed rock, soil, or sand with a maximum aggregate size of 1/2-inch. 100percent of the aggregate shall pass the 3/4" sieve and not more than 30-percent retained on the 3/8" sieve and not more than 12 percent shall pass the No. 200 sieve. Air entraining admixtures shall be added to improve the workability and shall in accordance with the requirements of ASTM C260. Density of CLSM shall be between 120 pounds per cubic feet to 135 pounds per cubic feet. Minimum 28-day compressive strength for CLSM shall be between 50psi minimum to 100psi for depths 20 feet or less in height of cover. For depths greater than 10 feet in height, CLSM mix shall have a minimum 28-day compressive strength of 100 psi.

4. **Native** material shall be material obtained from on-site excavations, provided the materials are not classified as unsuitable. Native materials shall be free of stones, lumps, rubbish, debris, organic material, broken concrete or bituminous surfacing over 4 inches in diameter, objectionable material, vegetation, and deleterious substances.
5. **Class 2 Permeable Material** shall be hard, durable, crushed stone, or gravel, and free from slaking or decomposition under action of alternate wetting or drying, uniformly graded, and shall meet the requirements of Section 68-2.02F for Class 2 "Permeable Material", of the State Standard Specifications.
6. **Topsoil** shall be material which has been obtained at the site or may be imported and shall meet the requirements of [Section 32 90 00 - Landscape Work](#). Removal of topsoil shall be done after the area has been stripped of vegetation and debris as specified.

2.2 UNSUITABLE BACKFILL MATERIALS

- A. Any material determined to be hazardous is defined as unsuitable material.
- B. Unsuitable soils for backfill material shall include soft, spongy, unstable or other similar soils which, when classified under ASTM D 2487, fall in the classifications of Pt, OH, or OL. Types CH and MH soils will be permitted in unimproved areas only where required compaction and stability can be demonstrated. In addition, any soil which cannot be compacted sufficiently to achieve the percentage of maximum density specified for the intended use, shall be classified as unsuitable material.
- C. Washed, smooth rock (pea gravel) is classified as unsuitable material.

2.3 FILTER FABRIC

- A. Filter Fabric shall be permeable, non-woven synthetic fabric meeting the requirements of Section 96-1.02B, "Filter Fabric" of the State Standard Specifications. Filter fabric shall have minimum Grab breaking load in each direction of 157 pounds, a minimum puncture strength of 310 pounds, apparent opening size between 40 and 70.

2.4 TEMPORARY STEEL PLATES

- A. When approved by the Project Manager, the Contractor may use steel plate bridging in-lieu of backfill and temporary asphalt where the roadway surface is to be opened to traffic. All steel plates shall be without deformation. Inspectors shall

determine the trueness of steel plates by using a straight edge and shall reject any plate that is permanently deformed.

- B. Trench plates shall be coated with Antiskid type surface meeting State Standard Specifications of a nominal Coefficient of friction of 0.35 in accordance with California Test Method 342 (Appendix H).
- C. The following table shows the advisory minimal thickness of steel plate bridging required for a given trench width (A-36 grade steel, designed for HS20-44 truck loading per Caltrans Bridge Design Specifications Manual).

Trench Width	Minimum Steel Plate Thickness (inches)
10 inches	1/2 inch
1 feet 11 inches	3/4 inch
2 feet 7 inches	7/8 inch
3 feet 5 inches	1 inch
4 feet 3 inches	1-3/4 inch

NOTE: For trench width spans greater than 4 feet 3 inches, a structural design shall be prepared, signed, and stamped by a California Registered Civil Engineer.

- D. A Rough Road signs (W8-8) with black lettering on an orange background shall be used in advance of steel plate bridging.

PART 3 - EXECUTION

3.1 DEFINITIONS - PIPE ZONE, BEDDING, TRENCH & FINAL ZONE

- A. **Pipe Zone:** Pipe Zone is defined as the vertical trench cross-section between the trench subgrade, which is 0.4 times the outside diameter of the pipe in inches below the bottom surface of the pipe or 4” minimum whichever is greater, and 12 inches above the top surface of the pipe.
- B. **Bedding:** Bedding is defined as that portion of the Pipe Zone between the trench subgrade, which is 0.4 times the outside diameter of the pipe in inches below the bottom surface of the pipe or 4” minimum whichever is greater and a level line from the bottom of the pipe.
- C. **Trench Zone:** The Trench Zone is defined as the vertical trench cross-section between top of Pipe Zone and 36” below finish paved surface. In unpaved areas, the Trench Zone shall be the vertical cross-section between the top of Pipe Zone and 24 inches below finished unpaved or landscape surface.

- D. **Final Zone:** The Final Zone is defined as the upper 36 inches of vertical cross-section below the finished paved surface. In unpaved or landscaped areas, the Final Zone is the upper 24 inches of vertical cross-section below the finished surface.
- E. **Pavement Section:** The Pavement Section is defined as the engineered layers of pavement and base conforming to the hot mix asphalt pavement or concrete pavement and aggregate base thickness as shown on the Plans.
- F. **Backfill:** Backfill is considered to be the material used to fill the portion of a trench between the pipe Bedding and the roadway subgrade or finish surface in non-roadway areas
- G. **Trench Plugs:** Trench plugs are temporary barriers placed within an open trench excavation in order to minimize the volume and velocity of trench water flow at the base of slopes and to reduce erosion in the trench, preventing the trench from becoming a subsurface drainage path. These trench plugs may consist of unexcavated portions of the trench, compacted subsoil, sandbags, or some functional equivalent.

3.2 PIPE ZONE BACKFILL MATERIALS

- A. Bedding as defined in this section shall be Sand or Class 2 Aggregate Base.
- B. Pipe Zone backfill, excluding bedding as defined in this section shall be
 1. Sand for plastic pipe
 2. Sand or Class 2 Aggregate Base for ductile iron pipe, vitrified clay pipe and reinforced concrete pipe.
- C. For dry utility and/or joint trench, Pipe Zone backfill shall conform to latest Pacific Gas and Electric Company (PG&E) Greenbook's Engineering Material Specification No. 4123 - Backfill Sand or meeting the utility owner's specifications.
- D. Trench plugs shall be provided at minimum intervals of 200 feet where pipelines are installed on grades exceeding 4 percent, and where backfill materials have gradation less than 10 percent passing a No. 4 sieve.
- E. Unless otherwise specified Bedding and backfill around sub-drainage systems shall be minimum of 12 inches of Class 2 Permeable Material as specified in Section 68-2.02F(3) of the State Standard Specifications.

3.3 TRENCH ZONE BACKFILL MATERIALS

- A. Trench Zone backfill as defined in this section shall be Class 2 Aggregate Base in paved areas.

- B. Native backfill material shall be used in unpaved or landscape areas.

3.4 FINAL ZONE BACKFILL MATERIALS

- A. Final Zone backfill as defined in this section shall be
 1. Native backfill in unpaved areas
 2. Native backfill with 6 inches thick minimum Top Soil material in landscape areas.
 3. Class 2 Aggregate Base in paved areas below the Pavement Section.

3.5 TRENCH WIDTH & LENGTH

- A. Minimum Trench width shall be as follows:

Utility Pipe Outside Diameter (O.D.) (inches)	Minimum Trench Width (inches)
For Pipe Sizes under 12 inches	Pipe O.D. + 12 inches
For Pipe Sizes between 12 inches to 48 inches	Pipe O.D. + 24 inches
For Pipe Sizes above 48 inches	Pipe O.D. + 48 inches

For Dry Utilities (electrical, telephone, cable, street light and traffic signal conduits), the trench width shall be 18" minimum.

- B. Maximum Length of Open Trench: Except by permission of the Project Manager, the maximum length of open trench where prefabricated pipe is used shall be the distance necessary to accommodate the amount of pipe installed in a single day and shall not exceed 300 feet. The distance is the collective length at any location, including open excavation, pipe laying and appurtenant construction and backfill which has not been temporarily re-surfaced.
- C. Except by permission of the Project Manager, the maximum length of open trench in any one location where concrete structures are cast in place will be that which is necessary to permit uninterrupted progress.

3.6 PREPARATION

- A. Call Local Utility Line Information service at USA North 811 not less than three working days before performing Work.
 1. Request underground utilities to be located and marked within and surrounding construction areas.

- B. Contractor's Licensed Land Surveyor shall provide all construction surveying and staking prior to beginning any trenching and excavation.
- C. Protect bench marks, street monuments, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.
- D. Contractor shall maintain and protect above and below grade utilities unless otherwise noted.
- E. Establish temporary traffic control per Contractor's approved traffic control plans when trenching is performed in public right-of-way. Relocate controls as required during progress of Work.

3.7 SHEETING AND SHORING

- A. Sheet, shore, and brace excavations more than 5 feet deep to prevent danger to persons, structures and adjacent properties and to prevent caving, erosion, and loss of surrounding subsoil.
- B. All sheeting, shoring and bracing shall conform to Cal/OSHA.
- C. Support trenches more than 5 feet deep excavated through unstable, loose, or soft material. Provide sheeting, shoring, bracing, or other protection to maintain stability of excavation.
- D. Design sheeting and shoring to be removed at completion of excavation work.
- E. Repair damage caused by failure of the sheeting, shoring, or bracing and for settlement of filled excavations or adjacent soil.
- F. Repair damage to new and existing Work from settlement, water or earth pressure or other causes resulting from inadequate sheeting, shoring, or bracing.
- G. **Access to Trenches** - A stairway, ladder, ramp or other safe means of egress shall be located in trench excavations that are 4 feet or more in depth so as to require no more than 25 feet of lateral travel for the employees, the Contractor, and any other personnel.
- H. **Bracing Excavations** - The manner of bracing excavations shall be as set forth in the rules, orders and regulations of the Division of Industrial Safety of the State at California.

3.8 TEMPORARY ACCESSIBLE PEDESTRIAN BRIDGES

- A. Temporary Accessible Pedestrian bridges of approved construction not less than four feet in width in compliance with ADA, and provided with hand rails and supports of dressed lumber, shall be installed over trenches at all crosswalk

intersections, and at such other points where traffic conditions make it advisable. Substantially constructed bridges, adequate for handling all vehicular traffic, shall be installed over any trench or other excavation in a street intersection, whenever such excavation is in excess of half the width of the street crossing. Adequate bridges shall be provided to make possible the safe and full use of all driveways or roadways used to move vehicles from the public street onto private property.

- B. All bridges required to be installed shall be maintained in place as long as the condition of the work requires their use for the safety and convenience of the public. Removal or relocation of these temporary bridges shall be at the Contractor's own discretion and risk.

3.9 TRENCHING AND EXCAVATION

- A. All excavations for utilities, pipelines and Minor Structures shall be open cut trenches, unless otherwise shown.
- B. Do not advance open trench more than 200 feet ahead of installed pipe.
- C. Cut trenches to widths per Standard Specifications or as indicated on the Drawings and sufficiently wide to enable installation and allow inspection. Remove water or materials that interfere with Work.
- D. Excavate trenches to depth per Standard Specifications or as indicated on Drawings. Provide uniform and continuous bearing and support for bedding material and utility pipes.
- E. Do not interfere with 45-degree bearing splay of foundations.
- F. When Project conditions permit, slope side walls of excavation per Cal/OSHA. When side walls cannot be sloped, provide sheeting and shoring to protect excavation as specified in this section.
- G. Excavation and other work under or adjacent to existing pipe lines, cables, conduit runs or structures of any kind, shall be prosecuted in such a manner as not to interfere with the safe operation and use of such installations. Should any damage be incurred to existing facilities during the Contractor's operations, the Contractor shall immediately notify the proper owners or authorities, and shall arrange for the immediate repair of same at the Contractor's own expense.
- H. Excavations for appurtenant structures, such as but not limited to maintenance holes, transition structures, junction structures, vaults, valve boxes, catch basins, thrust blocks, and boring pits shall, for the purpose of shoring and bracing, be deemed to be in the category of trench excavation.
- I. Excavation shall include the removal of all water and materials of any nature which interfere with the construction work. Removal of ground water to a level

below the structure sub-grade will be necessary unless specified otherwise. The water removed during excavation shall not be directed to storm drain system. The contractor shall apply to Delta Diablo for a Discharge Permit to dispose the water encountered during excavations into the sanitary sewer system.

- J. Should the Contractor elect to tunnel or jack any portion, he shall first obtain approval from the Project Manager. Payment for such work will be made as though the originally specified method of construction has been used.
- K. Trenching, tunneling, boring and jacking shall comply with the applicable provisions of the State Standard Specifications, these specifications and the plans. All work shall comply with the applicable Federal, State and local laws, regulations, codes and ordinances, and in addition, shall meet the respective utility agencies requirements for joint trench construction for installation of conduits, including, but not limited to, safety, depth, size, type, connection and other regulations and shall be considered as included in the various contract items of work and no additional compensation shall be made therefore.
- L. Pipe will be carefully inspected in the field before and after laying. If any cause for rejection is discovered in a pipe after it has been laid, it shall be subject to rejection. Any corrective work shall be approved by the Project Manager and shall be at no cost to the City.
- M. When connections are to be made to any existing pipe, conduit, or other appurtenances, the actual elevation or position of which cannot be determined without excavation, the Contractor shall excavate for, and expose, the existing improvement before laying any pipe or conduit. The Project Manager shall be given the opportunity to inspect the existing pipe or conduit before connection is made.
- N. Gravity flow pipe shall be laid downstream to upstream with the socket or collar ends of the pipe upgrade unless authorized by the Project Manager.
- O. Concrete pipe with elliptical reinforcement shall be laid with the minor axis of the reinforcement cage in a vertical position.
- P. Any adjustments in line or grade of not more than 0.1 feet up or down which may be necessary to accomplish the intent of the plans shall be considered as included in the various contract items of work and no additional compensation will be made therefore.
- Q. Locations of existing underground utilities and structures, insofar as they are known from information furnished by the respective utility companies and agencies, have been shown on the plans. The City assumes no responsibility for the accuracy or completeness of said data, which is offered solely for the convenience of the Contractor it shall be the Contractor's responsibility to verify the location of these obstructions, and to locate any other underground utilities or structures, which might interfere with the Contractor's operations.

- R. If soft spongy, unstable or other similar material is encountered upon which the bedding material or pipe is to be placed, this unsuitable material shall be removed to a depth ordered by the Project Manager and replaced with bedding material suitably densified. Additional bedding so ordered, over the amount required by the plans or specifications, will be paid for as provided in the Proposal or the Technical Specifications. If the necessity for such additional bedding material has been caused by an act or failure to act on the part of the Contractor, or is required for the control of ground water, the Contractor shall bear the expense of the additional excavation and bedding.
- S. Where pipe culverts are to be installed in new embankment, it shall first be constructed to the required height as shown on the plans, and for a distance each side of the culvert location of not less than five (5) times the diameter of the culvert, after which the trench shall be excavated with sides as nearly vertical as soil conditions will permit and culvert installed
- T. For excavations in landscape areas, all damaged irrigation systems, including irrigation piping and electrical wiring shall be repaired and restored to the original condition on the same day they are damaged. All landscape surface areas shall be restored to its original condition unless specified otherwise.
- U. No tree roots over 1.5 inches in diameter shall be cut without the authorization from the Project Manager or City's Arborist. If existing roots over 1 inch in diameter are cut during the course of work, the cut faces shall be thoroughly coated with emulsified asphalt made especially for use on cut or damaged plant tissues. All exposed roots shall be covered with wet burlap to prevent them from drying out.
- V. Trim excavation. Hand trim for bell and spigot pipe joints. Remove loose matter.
- W. Correct over excavated areas with compacted backfill as specified for authorized excavation as directed by Project Manager.
- X. Remove excess subsoil not intended for reuse, from site. The legal disposal of excess materials shall be the responsibility of the Contractor.
- Y. Use of explosives and blasting material will not be permitted.
- Z. Stockpile excavated material in area designated on site as shown on the Contractor's approved Staging Plans.
- AA. In areas of high vehicular or pedestrian volumes, the Project Manager may order the immediate removal of excavated material and that sidewalks and gutters be kept clean at all times.
- BB. The Contractor may transport or backhaul material to be used as backfill material from any portion of a project to any other portion or line of the same project, or from any project being constructed under one contract to any other project being

constructed under that same contract. Such transported material shall be clean soil, free from organic material, trash, debris, rubbish, or other objectionable substances except that broken Portland cement concrete or bituminous type paving allowable for the type of backfill specified may be permitted

3.10 OVER-EXCAVATION

- A. When ordered by the Project Manager, whether or not indicated in the project plans and specifications, trenches shall be over-excavated beyond the depths shown and such over-excavation shall be to the depths ordered the Project Manager. Backfill for over excavation backfill shall be Class 2 Permeable materials. For wet trenches, Contractor shall install a filter fabric on top and below the permeable materials.

3.11 PIPE LAYING

- A. Lay pipes to lines and grades indicated on Drawings, with uniform bearing under the full length of the barrel of the pipe. Project Manager reserves right to make changes in lines, grades, and depths of utilities when changes are required for Project conditions.
- B. Pipe sections shall be laid and joined in such a manner that the offset of the inside of the pipe at any joint will be held to a minimum at the invert. The maximum offset at the invert of pipe shall be 1 percent of the inside diameter of the pipe or 3/8 inch, whichever is smaller.
- C. After the joints have been made, the pipe shall not be disturbed in any manner.
- D. At the close of work each day, or whenever the work ceases for any reason, the end of the pipe shall be securely closed unless otherwise permitted by the Project Manager.
- E. All pipe shall be installed in accordance with the manufacturer's recommendations.
- F. The interior of the pipe shall be clean and free from foreign materials before sections of the pipe are connected. The open ends of the pipe shall be sealed with watertight plugs or other approved means at times when pipe laying is not in progress. Under no conditions shall ground water be allowed to enter the pipe.
- G. Dropping or bumping of pipe will not be permitted. Care shall be exercised by the Contractor to prevent damage to the pipe during handling. There shall be no distortion or deflection of the pipe which might induce damage to the pipe, pipe lining, pipe coating or joints.

- H. Pipe will be carefully inspected in the field before and after laying. In no event shall rejected pipe be installed. Any pipe failing to pass inspection after laying shall be subject to rejection. Any corrective work shall be approved by the Project Manager and shall be at no cost to the City.
- I. The Contractor shall provide a minimum of twelve (12) inches vertical clearance between the pipe and proposed or existing facilities and improvements or per the Utility owner's requirements. A minimum of twelve inches (12 inches) vertical clearance between the pipe and sanitary sewers, gas or petroleum lines and telephone cables shall be provided. Clearance for electrical conduits shall be as provided in the applicable General Safety Orders or utility regulations. Sanitary sewer and water lines shall be 10 feet horizontally clear and not in the same trench and in conformance with Water Main Separation Criteria: Chapter 16 - California Waterworks Standards Article 6 - §64572, unless specifically shown or directed by the Project Manager.
- J. Every precaution shall be taken against floating the pipe. In case of such floating, the Contractor shall replace the pipe to its proper location at his own expense, and replace any damaged pipe which may have resulted.

3.12 PLACING AND SPREADING OF BACKFILL MATERIALS

- A. Regardless of compaction method, backfill shall be evenly spread in horizontal layers so that when compacted each layer shall not exceed eight (8) inches in thickness. During spreading, each layer shall be thoroughly mixed as necessary to promote uniformity of material and uniformity of moisture throughout backfill materials. Material placed in excess of eight (8) inches in thickness shall be removed and re-compacted with the next lift.
- B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.
- C. Water shall be added before or during spreading until the proper moisture content is achieved where the backfill material moisture content is below the optimum moisture content.
- D. Where the backfill material moisture content is too high to permit the specified degree of compaction, the material shall be dried or replaced until the moisture content is satisfactory.
- E. Unless otherwise approved by the Project Manager, all trenches within the existing roadway shall be backfilled completely and the roadway made passable to traffic at the end of each day's operation.
- F. Backfill, or fill, as the case may be, for cast-in-place structures such as, but not limited to, manholes, transition structures, junction structures, vaults, valve boxes and reinforced concrete conduits shall start at the sub-grade for the structure.

- G. Except where the pipe must remain exposed for force main leakage tests and subject to the provisions herein, the Contractor shall proceed as soon as possible with backfilling operations. Care shall be exercised so that the conduit will not be damaged or displaced. If the pipe is supported by concrete bedding placed between the trench wall and the pipe, the remainder of any bedding material shall be placed to 1 foot over the top of the conduit. The backfill above the concrete bedding shall not be placed nor sheeting pulled until the concrete has attained sufficient strength as required by the Project Manager.
- H. Trenches shall not be backfilled until all required pressure tests are performed and until the utilities systems as installed conform to the requirements specified in the several sections covering the installation of the various utilities.
- I. Voids left by the removal of sheeting, piles and similar sheeting supports shall be immediately backfilled and compacted into place to assure dense and complete filling of the voids.
- J. After the placing of backfill has been started, the Contractor shall proceed as soon as practicable with compaction.
- K. Backfill shall be mechanically compacted by means of tamping rollers, sheepsfoot rollers, pneumatic tire rollers, vibrating rollers, or other mechanical tampers. All such equipment shall be of a size and type approved by the Project Manager. Impact-type pavement breakers (stompers) will not be permitted. Sheepsfoot equipment shall be limited to outside the Pipe Zone.
- L. Permission to use specific compaction equipment shall not be construed as guaranteeing or implying that the use of such equipment will produce required results or will not result in damage to adjacent ground, existing improvements, or improvements installed under the contract. The Contractor shall make its own determination in this regard.
- M. Material for mechanically compacted, backfill shall be placed in lifts which, prior to compaction, shall not exceed the thickness specified above.
- N. Mechanically compacted backfill shall be placed in horizontal layers of thickness compatible to the material being placed and the type of equipment being used. Each layer shall be evenly spread, moistened (or dried, if necessary), and then tamped, vibrated or rolled until the specified relative compaction has been attained.

3.13 COMPACTION OF BACKFILL MATERIALS

- A. Compaction of backfill materials shall be in accordance with ASTM D1557 for cohesive type soils and in accordance with ASTM D4253 and D4254 for cohesionless, free-draining granular type materials. The following compaction test requirements shall apply:

Location of backfill	Relative Compaction
Pipe Zone (including Bedding)	90
Trench Zone	90
Final Zone (paved areas, excluding the Pavement Section)	95
Final Zone (unpaved or landscape areas)	90
Over-excavated areas	90
Around minor structures	90
Beneath minor structures	95

- B. Compaction of Pipe Zone including Bedding material shall be by hand tamping, hand held mechanical vibrating equipment or other means approved by the Project Manager.
- C. Each layer of backfill material shall be mechanically compacted to the specified percentage of maximum density. Equipment that is consistently capable of achieving the required degree of compaction shall be used and each layer shall be compacted over its entire area while the material is at the required moisture content range. Flooding, ponding, or jetting shall not be used.
- D. Use hand operated power compaction equipment where use of heavier equipment is impractical or restricted due to weight limitations.
- E. Backfill within 3 feet of structures or walls shall be compacted with hand operated equipment. Do not use equipment weighing more than 10,000 pounds closer to walls than a horizontal distance equal to the depth of the fill at that time.

3.14 TEMPORARY RESURFACING

- A. Unless permanent pavement is placed immediately, temporary bituminous re-surfacing 2 inches thick shall be placed and maintained in streets and parking lot areas and at locations determined by the Project Manager wherever excavation is made through pavement, sidewalk or driveways. Temporary asphalt shall be placed flush with the adjacent pavement grade.
- B. Hot Mix Asphalt shall be used for temporary resurfacing when permanent surfacing is not to be placed within seven (7) days.
- C. In sidewalk areas the temporary bituminous re-surfacing shall be at least 1-inch-thick, in all other areas it shall be at least 2 inches thick. At major intersections and other critical locations, a greater thickness may be ordered. Temporary resurfacing shall be placed as soon as the condition of the backfill is suitable to receive it and shall remain in place until the condition of the backfill is suitable for permanent resurfacing. Surfacing shall be maintained in a smooth and level condition. The temporary paving shall conform to the requirements of Section 39

of the State Standard Specifications and unless specified differently in the Technical Specifications, may use any of the mixes allowed in Section 39 for such temporary surfacing of trenches.

- D. The re-surfacing shall be placed, rolled, maintained, removed and disposed of by the Contractor.

3.15 PAVEMENT SECTION REPLACEMENT

- A. Unless otherwise specified on the plans or in the Technical Specifications, all existing pavement surface improvements damaged or removed as a result of the Contractor's operations shall be reconstructed by the Contractor per City of Pittsburg Standard Detail R-5, to same dimensions, except for pavement thickness, and with the same type materials used in the original work. Trench resurfacing shall match the existing pavement thickness, but no less than 3 inches.
- B. The type and thickness of the replacement pavement, base, cement treated base, and sub-base for trenches in public streets and highways shall be as shown on the plans or designated by the Project Manager.
- C. Unless otherwise specified, the following requirements shall govern:

Sub-base: Existing sub-base shall be replaced with Class 2 Aggregate Base. The thickness of sub-base replacement shall be designated by the Project Manager, and that portion of trench backfill lying within such designated limits shall be compacted in accordance with this Section and shall not be less than ninety-five (95) percent as determined by California Test Method No. 216.

- D. Surfacing of trenches in new street sections shall be as required to match the Pavement Section as shown on the project plans and specifications.

3.16 TOLERANCES

- A. [Section 01 45 00 - Quality Control](#): Tolerances.
- B. Top Surface of Backfilling under paved areas: Plus or minus 1/2 inch from required elevations.
- C. Top Surface of General Backfilling: Plus or minus 1/2 inch from required elevations.

3.17 FIELD QUALITY CONTROL

- A. [Section 01 45 00 - Quality Control](#): Field inspecting, testing, adjusting, and balancing.

- B. Perform laboratory material tests in accordance with ASTM D1557, ASTM D698, and AASHTO T180.
- C. Perform in place compaction tests in accordance with the following:
 - 1. Density Tests: ASTM D1556, ASTM D2167, or ASTM D2922.
 - 2. Moisture Tests: ASTM D3017.
- D. When tests indicate Work does not meet specified requirements, remove Work, replace, compact, and retest at the Contractor's expense.

3.18 PROTECTION OF FINISHED WORK

- A. [Section 01 77 00 - Closeout Requirements](#): Contractor shall protect all the finished work and any damage to the finished work shall be replaced at the Contractor's expense.

3.19 TEMPORARY STEEL PLATE BRIDGING

- A. When backfilling operations of an excavation in the roadway including bike lanes, sidewalks and parking strip, whether transverse or longitudinal, cannot be properly completed within a work day, steel plate bridging with a non-skid surface and shoring shall be required to preserve unobstructed traffic and pedestrian flow. In such cases, the following conditions shall apply:
 - 1. Steel plates used for bridging must extend a minimum of 12-inches beyond the edges of the trench.
 - 2. Steel plate bridging shall be installed to operate with minimum noise or movement.
 - 3. The trench shall be adequately shored to support the bridging and traffic loads.
 - 4. Temporary paving with cold asphalt concrete shall be used to feather the edges of the plates, if plate installation by Method (2) described below, is used.
 - 5. Bridging shall be secured against displacement by using adjustable cleats, shims, or other devices.
- B. The Contractor is responsible for maintenance of the steel plates, shoring, asphalt concrete ramps, and ensuring that they meet minimum specifications.
- C. All work done by the City crews for lack of maintenance of the temporary steel plates as specified above by the Contractor shall be back charged to the Contractor.
- D. Steel plate bridging shall not exceed four (4) consecutive working days in any given week and should not be left through the weekend, unless approved by the Engineer.

- E. Steel plate bridging and shoring shall be installed using either Method (1) or (2):
1. **Method 1** For speeds of 45 MPH or greater:

The pavement shall be cold planed to a depth equal to the thickness of the plate and to a width and length equal to the dimensions of the plate. Approach plate(s) and ending plate (if longitudinal placement) shall be attached to the roadway by a minimum of two (2) dowels pre-drilled into the corners of the plate and drilled 2-inches into the pavement. Subsequent plates are to be butted and tack welded to each other.

2. **Method 2** For speeds less than 45 MPH:

Approach plate(s) and ending plate (if longitudinal placement) shall be attached to the roadway by a minimum of two (2) dowels pre-drilled into the corners of the plate and drilled 2-in into the pavement. Subsequent plates are to be butted and tack welded to each other. Fine graded asphalt concrete shall be compacted to form ramps, maximum slope 8.5 percent with a minimum 12-inch taper to cover all edges of the steel plates. When steel plates are removed, the dowel holes in the pavement shall be backfilled with either graded fines of asphalt concrete mix, concrete slurry, epoxy or an equivalent that is satisfactory to the Project Manager.

END OF SECTION 31 23 16

SECTION 31 50 00
EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Temporary excavation support systems.

1.2 REFERENCED SECTIONS

- A. The following Sections are referenced in this Section
1. Section 01 33 00 – Submittals
 2. Section 02081 – Controlled Low Strength Material
 3. Section 02262 – Settlement Monitoring
 4. Section 02300 – Earthwork
 5. Section 03 60 00 – Grouts

1.3 DEFINITIONS

- A. Protection Systems:
1. Sloping or benching systems for excavated slopes.
 2. Structural support systems, shield systems, and other systems for preventing excavation wall failure.

1.4 SUBMITTALS

- A. Prepare and submit in accordance with Section 01 33 00.
- B. Submit information as a complete package. Include all items required by the Contract Documents. Incomplete submittals will not be reviewed and will be returned for resubmittal as a complete package.
- C. Shop Drawings
1. Prepared, signed and sealed by a professional engineer who is registered to practice in the State of California.
 2. Clearly indicate structural sections of shoring members, welding details, bolting details and bracing details.
 3. Indicate existing and new structures, pipelines and other improvements located in the vicinity and impacting the design of the shoring system.
 4. Provide details for bracing, reinforcement and sealing around penetrations.
- D. Calculations: Structural calculations verifying and demonstrating the structural safety and adequacy of the sheeting, shoring and bracing to be used.
1. Prepared, signed and sealed by a registered Professional Civil or Structural Engineer who is registered to practice in the State of California.
 2. Provide calculations for the different load, support and other conditions that occur during the sequence of installation, construction of facilities protected by the shoring and the sequence of removal of the internal bracing and shoring.

- E. Sheet Pile Driving Equipment: Information on type of equipment to be used, including manufacturer, model number and driving energy.
- F. Qualifications of registered Professional Engineer and shoring installer, including project references.
- G. Prepare a detailed plan illustrating the sequence of installation and removal of shoring systems and internal bracing. Include sketches showing the various stages in the sequence.
- H. Letter confirming installation of the shoring system is in accordance with the shoring design.
- I. Control Points and Stability Measurements:
 - 1. Submit proposed location and details of control points and method and schedule for obtaining stability measurements.
 - 2. Submit field notes documenting stability measurements.

1.5 INSTALLER QUALIFICATIONS

- A. Shoring installer must have a minimum of five successful past installations of shoring systems of comparable overall heights and comparable penetration of soils similar to those found on the project site.

1.6 PERFORMANCE REQUIREMENTS

- A. Design and install excavation support and protection systems that are capable of:
 - 1. Supporting excavation sidewalls and bottom to maintain the required excavation or trench section.
 - 2. Resisting soil and hydrostatic pressure and superimposed construction loads and other live loads.
 - 3. Protecting existing facilities in the vicinity of the excavation from damage due to settlement or movement of soil
- B. Provide professional engineering services necessary to assume engineering responsibility, including preparation of Shop Drawings and a comprehensive engineering analysis by a qualified professional engineer registered in the State of California.
- C. Install and remove excavation support and protection systems without damaging existing buildings, pavements, utilities, railroad facilities and other improvements adjacent to excavation.
- D. Excavations
 - 1. Protect workers from hazard of caving ground and other hazards.
 - 2. Install excavation protection system in locations where:
 - a. Protection system is specifically indicated on the Drawings.
 - b. Excavations are equal to, or greater than, 5 feet deep.
 - c. Excavations are less than 5 feet deep, but there is a potential for cave-in.
 - d. When engineering analyses prepared by the Contractor indicate the stability of existing structures and facilities may be jeopardized by settlement or movement of soil.

1.7 GENERAL DESIGN REQUIREMENTS

- A. Design excavation support systems to meet requirements and standards of the Occupational Safety and Health Administration (OSHA).

- B. Design excavation support systems to meet the requirements of California Code of Regulations, **Title 8** – Construction Safety Orders and California Labor Code Sections 6705 to 6707.
- C. Design structural steel members in accordance with the American Institute of Steel Construction (AISC) Manual of Steel Construction Allowable Stress Design and the Uniform Building Code.
- D. Excavation support systems for trench excavations shall be selected by the Contractor based on the soil conditions, depths of trench excavations, groundwater conditions and other site conditions. No attempt has been made by Engineer to define acceptable trench shoring options.
- E. Excavation support systems for structural excavations may consist of either **driven steel sheet piling or soldier beam and lagging systems** complying with requirements of this Section. Contractor may select from either specified system.
- F. Allowable Deflection: Not more than **[1/2-inch] [_____]** at any point on the shoring system.
- G. Cantilevered Design Limits:
 - 1. Maximum height of cantilevered shoring above the bottom of the excavation shall not exceed 15 feet.
- H. Resistance to Overturning
 - 1. Design soldier piles and sheet piles with sufficient depth below the excavation to:
 - a. Resist lateral movement or overturning of the pile, and
 - b. Act as an effective water cutoff to prevent heaving or flow of soil into the excavation.
 - 2. Calculate the required depth of pile below the bottom of the excavation by assuming the soil immediately below the bottom of excavation does not provide passive resistance for a depth of 1.5 times the effective pile diameter.

1.8 DESIGN REQUIREMENTS FOR SOLDIER PILES AND LAGGING

- A. Design soldier piles for downward loads including vertical loads from tie back anchors.
- B. Flexural Strength of Lagging: In accordance with the Uniform Building Code, but not greater than 1,500 psi.
- C. Wales: Use back-to-back structural members.
- D. Soil Anchors, Rock Anchors and Deadmen Anchors:
 - 1. Design tie back anchors with a safety factor of not less than 2 times the calculated load from the shoring.
 - 2. When calculating the length of soil anchors needed to resist the load from the shoring, do not include any anchor length within the potential active pressure soil failure zone behind the face of the shoring.
 - 3. Design anchor tie rods for 130 percent of the calculated load from the shoring.
 - 4. When tie rod couplings are used, design anchor tie rods for 150 percent of the calculated load from the shoring.

1.9 GEOTECHNICAL REPORT

- A. **A geotechnical report has been prepared for this Project and is available for information only. The geotechnical report is not part of the Contract Documents. The opinions expressed in this report are those of geotechnical engineer and represent interpretations**

of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for design of the excavation support systems.
2. Copies of the geotechnical report [are bound in this Project Manual but are not a part of the Contract Documents.] [are available for inspection at _____ .]

1.10 PROJECT SPECIFIC DESIGN REQUIREMENTS

- A. [TBD]
- B. [TBD]

1.11 JOB SITE POSTINGS

- A. Maintain at least one copy of the protection system design at the job site while the excavation is open in accordance with the requirements of California Code of Regulations, Title 8 Construction Safety Orders and the California Labor Code.

1.12 SEQUENCE AND SCHEDULING

- A. Do not begin excavations or installation of excavation supports until submittals for excavation support systems have been accepted by the Engineer and until materials necessary for installation are on site.
- B. Allow a minimum of 30 calendar days for Engineer's review of submittals for excavation support systems.
- C. Do not begin excavations or installation of excavation supports until initial survey measurements on control points on existing structures and other improvements are obtained to document initial elevations and locations.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Provide materials that are either new or in serviceable condition.
- B. Structural Steel Soldier Beams: ASTM A36, ASTM A690 or ASTM A992.
- C. Steel Sheet Piling: ASTM A328, ASTM A572 or ASTM A690; with continuous interlocks.
- D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness as determined by design calculations, but not less than 3 inches.
- E. Lean Concrete Mix:
 1. Controlled Low Strength Material in accordance with Section 02081.
 2. A mixture of sand, fine aggregate, water and 2 sacks of cement per cubic yard to create a flowable mixture that fills voids.
 3. Minimum Compressive Strength: 1500 psi.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prior to beginning installation of the excavation support system, pothole to locate existing buried utilities in the vicinity of the excavation. Survey utilities and compare actual locations to those locations indicated on the Drawings and the Shop Drawings. Determine any areas

of conflict and revise the design and layout of the excavation support system to eliminate these conflicts.

3.2 SLOPING AND BENCHING OF EXCAVATED FACES

- A. Where structural excavation support systems are not specifically indicated on the Drawings, sloping and benching systems for exposed faces of excavations may be utilized.
- B. Construct sloping and benching systems in accordance with **Section 02300**.

3.3 TRENCHING SUPPORT SYSTEMS

- A. Where structural excavation support systems are not specifically indicated on the Drawings, trench support systems consisting of hydraulic jacks and plates, trench shield systems, and other trench protection systems may be utilized.

3.4 SOLDIER BEAMS AND LAGGING

- A. Before starting excavation, drive steel soldier beams or install steel soldier beams in pre-drilled holes.
 - 1. Installation of Soldier Beams in Pre-Drilled Holes
 - a. Diameter of pre-drilled hole: Not to exceed the outside dimensions of the soldier beam.
 - b. Backfill around soldier beam using a lean concrete mix.
- B. Space soldier beams at regular intervals not to exceed allowable flexural strength of the wood lagging. Align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.
- C. Install wood lagging within flanges of soldier beams as excavation proceeds. Trim excavation as required to install lagging.
- D. Install horizontal wales at locations indicated on the shop drawings and secure to soldier beams.
- E. Fill voids behind lagging with gravel, lean concrete or other material acceptable to the Engineer.

3.5 SHEET PILING

- A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock to form a continuous barrier. Align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment. Cut tops of sheet piling to uniform elevation at top of excavation.

3.6 BRACING

- A. Locate bracing to clear temporary and permanent work and to allow lowering of material and equipment into the excavation.
- B. If necessary to move brace, install new bracing before removing original brace.
- C. Install internal bracing when calculations indicate bracing is required to prevent spreading or distortion of braced frames.
- D. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.7 INSPECTION

- A. Designer of the shoring system is responsible for confirming proper installation of the shoring system. Shoring system designer, or a representative of the designer, shall make site visits to confirm installation is in accordance with the accepted shoring design.
- B. Submit letter of proper installation confirming installation is in accordance with the shoring design.

3.8 MONITORING AND STABILITY MEASUREMENTS

- A. Conduct monitoring and stability measurement in accordance with Section 02262.

3.9 REMOVAL

- A. Remove at least the top 10 feet of excavation support systems.
- B. Remove excavation support and protection systems when backfill can support the remaining open excavation and bear soil and hydrostatic pressures. Remove support and protection systems in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.
- C. After removal, promptly fill voids resulting from the extraction of shoring with sand-cement grout conforming to the requirements of Section 03 60 00. Repair or replace adjacent work damaged or displaced by excavation support and protection systems removal.

END OF SECTION

SECTION 32 11 23 - AGGREGATE BASE COURSES**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Class 2 Aggregate Base course.

B. Related Sections:

1. [Section 31 23 16 - Utility Trenching](#): Compacted fill under base course.
2. [Section 32 12 16 - Asphalt Paving](#): Binder and finish asphalt courses.
3. [Section 32 13 13 - Concrete Surface Improvements](#): Finish concrete surface course.

1.2 UNIT PRICE - MEASUREMENT AND PAYMENT

A. Aggregate Base Course:

1. Basis of Measurement: By the cubic yard as specified in the bid form. Quantities of aggregates will be calculated on the basis of dimensions shown on the plans. No allowance will be made for aggregate rejected or placed outside said dimensions unless otherwise order by the Project Manager.
2. Aggregate Base used under concrete work such as curb and gutter, valley gutter, sidewalk, driveways, curb ramps, median curbs, median nose surfacing, bus turnouts, retaining curbs, and in utility trenches shall not be measured unless specified otherwise in the Contract.
3. Basis of Payment: Includes full compensation for furnishing all labor, materials, tools, equipment and incidentals, in aggregate base supplying fill material, stockpiling, scarifying subgrade surface, placing where required, watering, dust palliative, leveling, compacting and certifying the top of aggregate base design grades.
4. Aggregate Base used under concrete work such as curb and gutter, valley gutter, sidewalk, retaining curbs, etc. shall considered incidental to the item most closely related to and no separate compensation will be allowed therefor. Aggregate base used in utility trenches shall be considered incidental to the cost per linear foot paid for the utility pipes as shown on the bid form and no separate compensation will be allowed therefor.

1.3 REFERENCES

- A. American Association of State Highway and Transportation Officials:
 - 1. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications.
- B. Caltrans Standard Specifications:
 - 1. Section 26 Aggregate Base.
- C. CalRecycle
 - 1. <http://www.calrecycle.ca.gov/ConDemo/Aggregate/>

1.4 SUBMITTALS

- A. [Section 01 33 00 - Submittal Procedures](#): Requirements for submittals.
- B. Product Data:
 - 1. Submit data for geotextile fabric and herbicide.
- C. Samples: Submit, in air-tight containers, 5 lbs sample of each type of aggregate fill to testing laboratory or as required by the City.
- D. Submit aggregate base gradation, R-value requirements, and sand equivalent requirements as specified in this sections.
- E. Aggregate samples must not be treated with lime, cement, or chemicals before testing for durability index.
- F. Aggregate from untreated reclaimed processed asphalt concrete, Portland cement concrete, lean concrete base or cement-treated base is not considered treated.
- G. If the aggregate gradation test results, sand equivalent test results, or both do not comply with the Contract compliance requirements, remove the aggregate base or request a payment deduction. If the payment deduction request is authorized, \$2.00/cubic yard is deducted.
- H. Materials Source: Submit name of aggregate materials suppliers.
- I. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- J. Field survey and certify the top of aggregate base design grades as specified in [Section 01 71 23 - Construction Surveying](#).

- K. Supplier shall submit certification data that aggregate base meets the requirements per Caltrans Testing Methods.

1.5 SUSTAINABLE DESIGN SUBMITTALS

- A. Manufacturer's Certificate: Certify products meet or exceed specified sustainable design requirements.
 - 1. Materials Resources Certificates:
 - a. Certify source and origin for salvaged and reused products.
 - b. Certify recycled material content for recycled content products.
 - c. Certify source for regional materials and distance from jobsite.

1.6 QUALITY ASSURANCE

- A. Furnish each aggregate material from single source throughout the Work.
- B. Perform Work according to City Standards.

PART 2 - PRODUCTS

2.1 SUSTAINABILITY CHARACTERISTICS

- A. Materials and Resources Characteristics:
 - 1. Recycled Content Materials: Furnish materials with maximum available recycled content.
 - 2. Regional Materials: Furnish materials extracted, processed, and manufactured within 500 miles of jobsite.

2.2 AGGREGATE MATERIALS

- A. Aggregate must be clean and consist of any combination of the following:
 - 1. Broken Stone
 - 2. Crushed Gravel
 - 3. Natural rough-surfaced gravel
 - 4. Sand
 - 5. Processed reclaimed asphalt concrete, Portland cement concrete, lean concrete base, or cement-treated base.
- B. Quality: Aggregate base furnished for the base material shall be free from vegetable matter and other deleterious substances, and shall be of such nature

that it can be compacted readily under watering and rolling to form a firm stable base.

- C. Maximum aggregate size shall be 3/4-inch maximum aggregate gradation unless specified otherwise.
- D. Class 2 Aggregate Base: ASTM D2940; graded type. Conform to Section 26 of the Caltrans Standard Specifications. Aggregate gradation for 3/4-inch maximum aggregate base must be within the percentage passing limits for the sieve sizes shown in the following table:

Aggregate Gradation

Sieve Size	Percentage Passing	
	Operating Range	Contract compliance
2"	-	-
1-1/2"	-	-
1"	100	100
3/4"	90-100	87-100
No. 4	35-60	30-65
No. 30	10-30	5-35
No. 200	2-9	0-12

- E. The aggregate quality characteristic must comply with the requirements shown in the following table:

Aggregate Quality Characteristics

Quality Characteristics	Requirement	
	Operating Range	Contract compliance
Resistance (R-value, min.)	-	78
Sand Equivalent (min.)	25	22
Durability Index (min.)	-	35

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify compacted subgrade is dry and ready to support paving and imposed loads.
 - 1. Proof roll subgrade with minimum two perpendicular passes to identify soft spots unless specified otherwise in the Project Geotechnical Report.
 - 2. Remove soft subgrade and replace with compacted fill unless specified otherwise in the Project Geotechnical Report or as ordered by the Project Manager.

- B. Immediately before spreading aggregate base, the subgrade must comply with the specified compaction and elevation tolerance for the material involved and be free from loose or extraneous materials.
- C. Contractor may use aggregate base to fill areas of the subgrade that are lower than the grade as shown on the Drawings.

3.2 PREPARATION

- A. Correct irregularities in subgrade gradient and elevation by scarifying, reshaping, and re-compacting.
- B. Do not place fill on soft, muddy, or frozen surfaces.

3.3 AGGREGATE PLACEMENT

- A. Deliver uniform thickness of aggregate base to the roadbed. Deposit aggregate base in layers or windrows.
- B. Spread and shape the aggregate base to such thickness that after watering and compacting, the completed aggregate base is within the tolerances specified below in Section 3.5.
- C. Avoid material segregation. Segregated materials shall be re-mixed until uniform.
- D. Aggregate base must be free from pockets of coarse or fine material.
- E. If the aggregate base thickness shown is 0.50 foot or less, spread and compact the aggregate base in one layer. If the thickness shown is more than 0.50 foot, spread and compact the aggregate base in at least 2 approximately equal layers in thickness. The compacted thickness of any one later must not exceed 0.50 foot.
- F. At locations inaccessible to spreading equipment, spread and compact aggregate base by any means that will attain the specified requirements; by hand compaction if needed.
- G. Apply water to moisture condition the aggregate base as needed for optimum moisture content for compaction.
- H. Compact each aggregate base layer to at least 95 percent relative compaction.
- I. If bi-axial is installed as shown on the Drawings or as directed by the City's Project Manager, compact aggregate base with either (1) a smooth-wheeled roller or (2) a rubber-tired roller. Do not use vibratory devices during compaction.
- J. Level and contour surfaces to elevations, profiles, and gradients indicated.

- K. Maintain optimum moisture content of fill materials to attain specified compaction density.
- L. Correct areas of aggregate base that do not comply with the described thickness.

3.4 TOLERANCES

- A. [Section 01 45 00 - Quality Control](#): Tolerances.
- B. Maximum Variation from Flat Surface: 1/4 inch measured with 10-foot straight edge.
- C. Maximum Variation from Thickness: 1/4-inch.
- D. Maximum Variation from Elevation: 1/4-inch.

3.5 FIELD QUALITY CONTROL

- A. [Section 01 77 00 - Closeout Requirements](#): Field inspecting, testing, adjusting, and balancing.
- B. When tests indicate Work does not meet specified requirements, correct areas of aggregate base that do not comply with the specified requirements and retest, or request a payment deduction. If a payment deduction is authorized, the deduction is calculated by multiplying:
 - 1. Deficient thickness less allowable tolerance
 - 2. Planned width
 - 3. Longitudinal distance of the deficient thickness
 - 4. \$17.00/cubic yard of the item price adjusted for cubic yards, whichever is higher

END OF SECTION 32 11 23

SECTION 32 12 16 - ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Asphalt materials.
2. Aggregate materials.
3. Type A HMA Asphalt paving
4. Tack coat
5. Asphalt Rubber Binder Seal Coat

B. Related Requirement:

1. [Section 32 11 23 - Aggregate Base Courses](#): Compacted subbase for paving.
2. [Section 33 05 13 - Manholes and Structures](#)

1.2 PRICE AND PAYMENT PROCEDURES

A. [Section 01 29 00 - Payment Procedures](#): Contract Sum/Price

B. Asphalt Paving or HMA:

1. Basis of Measurement: By ton and will be based on certified weight-meters certificates showing gross, net weight and the type and grading of the mix for each load unless specified otherwise on the Bid Form.
2. Basis of Payment: Includes priming surfaces, tack coating surfaces, fog seal, furnishing, placing, compacting asphalt pavement and temporary HMA tapers.

C. Asphalt Dikes:

1. Basis of Measurement: By lineal foot.
2. Basis of Payment: Includes priming surfaces, tack coating surfaces, furnishing, placing, compacting.

1.3 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:

1. AASHTO M17 - Standard Specification for Mineral Filler for Bituminous Paving Mixtures.

2. AASHTO M29 - Standard Specification for Fine Aggregate for Bituminous Paving Mixtures.
3. AASHTO M140 - Standard Specification for Emulsified Asphalt.
4. AASHTO M208 - Standard Specification for Cationic Emulsified Asphalt.
5. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications.
6. AASHTO M320 - Standard Specification for Performance-Graded Asphalt Binder.
7. AASHTO M324 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
8. AASHTO MP1a - Standard Specification for Performance-Graded Asphalt Binder.
9. AASHTO T283-14 – Standard Method of Test for Resistance of Compacted Asphalt Mixtures to Moisture-Induced Damage.
10. AASHTO T324 (Modified) -Hamburg Wheel-Track Testing of Compacted Hot Mix Asphalt (HMA).

B. Asphalt Institute:

1. AI MS-2 - Mix Design Methods for Asphalt Concrete and Other Hot- Mix Types.
2. AI MS-19 - Basic Asphalt Emulsion Manual.
3. AI SP-2 - Superpave Mix Design.

C. State Standard Specification:

1. Section 39 Asphalt Concrete.
2. Section 92 Asphalt Binder.
3. Section 94 Asphaltic Emulsions
4. Section 96 Geosynthetics

1.4 SUBMITTALS

A. [Section 01 33 00 - Submittal Procedures](#): Requirements for submittals.

B. Job Mix Formula (JMF): Except for the Hot Mix Asphalt (HMA) to be used in miscellaneous areas (median island areas not including inside shoulders, island areas, sidewalk, gutters, ditches, over side drains and aprons at end of drainage structures) and dikes, submit the proposed JMF for Type A HMA.

C. The JMF must be submitted on the Contractor Job Mix Formula Proposal form along with:

1. Mix design documentation on Contractor's Hot Mix Asphalt Design data form dated with 12 months of submittal.
2. Safety Data Sheets (SDS) for the following:
 - a. Asphalt Binder
 - b. Supplemental fine aggregate except fines from dust collectors
 - c. Antistrip additives.

- D. The Contractor's Hot Mix Asphalt Design Data form must show documentation on aggregate quality.
- E. Submit QC test results for Reclaimed Asphalt Pavement (RAP) gradation with the combined aggregate gradation within 2 business days of taking RAP samples during Type A HMA production.
- F. Contractor shall submit a new JMF if there are changes to any of the following:
 - 1. Target asphalt binder percentage greater than ± 0.2 percent.
 - 2. Asphalt binder supplier
 - 3. Combined aggregate gradation
 - 4. Aggregate sources
 - 5. Liquid antistrip producer or dosage
 - 6. Average binder content in a new processed RAP stockpile by more than ± 2.0 percent from the average RAP binder content reported on Contractor Hot Mix Asphalt Design Data form.
 - 7. Average maximum specific gravity in a new processed RAP stockpile by more than ± 0.060 percent from the average maximum specific gravity value reported on Contractor's Hot Mix Asphalt Design Data form.
 - 8. Any material in the JMF.
- G. Submit a current asphalt concrete mix design from two separate sources (primary source and backup source) for asphalt concrete proposed to be used.
- H. Contractor shall provide delivery tickets to the City at the time of delivery of each load of product, including asphalt concrete, tack coat, sealant, and paving reinforcement fabric. Each delivery ticket shall include or be accompanied by appropriate batch information produced by the batching plant or factory of origin and information stating the mix or model number, total yield in tons, gallons, or square feet, and time, date, and location of delivery.
- I. Any asphalt concrete rejected by the Project Manager shall be deducted from the total quantity of asphalt concrete tonnage.
- J. Reference Plan: Contractor shall have a walk through with the Project Manager for all installed underground boxes and/or iron elements, 10 days prior to any pavement repair. Contractor shall submit a reference plan (RP) to the Project Manager's review for utility facilities adjustment 3 working days prior to lowering any utility facilities.
- K. Contractor shall submit a paving plan for longitudinal joints.

1.5 QUALITY CONTROL PLAN

- A. The Contractor shall submit a Quality Control (QC) plan for HMA.
- B. The QC plan shall describe the organization and procedures for:

1. Controlling HMA quality characteristics
2. Taking samples, including sampling locations.
3. Establishing, implementing, and maintaining QC
4. Determining when corrective actions are needed.
5. Implementing corrective actions.
6. Using methods and materials for backfilling core locations.

C. The QC plan must address the elements affecting HMA Quality, including

1. Aggregates
2. Asphalt binder
3. Additives
4. Productions
5. Paving

D. For CIP projects, the Contractor shall permit the City’s certified testing laboratory to take samples of the aggregate and asphalt emulsion used in the project at the City’s discretion. Gradation and sand equivalent tests may be run on the aggregate and residual asphalt tests on the emulsion. City will compare the test results with this Section and notify the Contractor if any test fails to meet specifications.

E. The Contractor shall furnish all tools and equipment and employ sufficient trained personnel to operate all equipment and perform all handwork efficiently and skillfully.

1.6 AGGREGATES TESTING:

A. Contractor shall test the quality of aggregates under the test methods and frequencies shown in the following table and provide results to the City:

Aggregate Testing Frequencies

Quality Characteristic	Test Method	Minimum Testing Frequency
Gradation ^a	AASHTO T 27	1 per 750 tons and any remaining part
Sand Equivalent ^{b,c}	AASHTO T 176	
Moisture Content ^d	AASHTO T 255	
Crushed particles	AASHTO T335	1 per 10,000 tons or 2 per project whichever is greater
Los Angeles Rattler	AASHTO T96	
Flat and Elongated particles	AASHTO D4791	
Fine Aggregate angularity	AASHTO T 304 Method A	

^aIf RAP is used, test the combined aggregate gradation under California Test 384.

^bReported Value must be average of 3 tests from a single sample

^cUse of a sand reading indicator is required as shown in AASHTO T 176, Figure 1. Sections 4.7, “Manual Shaker,” 7.1.2, “Alternate Method No.2,” and 8.4.3, “Hand Method”, do not apply. Prepare the stock solution as specified in Section 4.8.1, “Stock solution with formaldehyde”, except omit the addition of formaldehyde.

^dTest at continuous mixing plants only. If RAP is used, test the RAP moisture content at continuous mixing plant and batch mixing plant.

1.7 AMBIENT CONDITIONS

- A. [Section 01 50 00 - Temporary Facilities and Controls](#): Ambient conditions control facilities for product storage and installation.
- B. Do not place HMA on wet pavement or frozen surface.
- C. Maximum lift thickness for asphalt paving shall be 4-inches unless shown otherwise on the Drawings.
- D. Spread Type A HMA at the ambient air and surface temperatures shown in the following table unless shown otherwise on the Drawings:

Lift Thickness (Feet)	Ambient air (°F)		Surface (°F)	
	Unmodified asphalt binder	Modified asphalt binder	Unmodified asphalt binder	Modified asphalt binder
< 0.15	55	50	60	55
≥ 0.15	45	45	50	50

PART 2 - PRODUCTS

2.1 ASPHALT PAVING

- A. Asphalt Concrete shall conform to Section 39, “Asphalt Concrete”, of the State Standard Specifications and the City Standard Specifications.
- B. Asphalt Concrete for surfacing shall be Hot Mix Asphalt (HMA) Type A.
- C. Asphalt Materials:
 - 1. Asphalt Binder: Asphalt Binder must comply with Section 92, “Asphalt Binders” of the State Standard Specifications.

- a. For a leveling course, the grade of the asphalt binder for the Hot mix asphalt (HMA) must be PG 64-10 or PG 64-16.
 - b. For Miscellaneous areas, and asphalt dikes the grade of the asphalt binder for the Hot mix asphalt (HMA) must be PG 70-10. Minimum asphalt binder content must be 6.40 percent for 3/8" maximum size aggregate.
 - 2. Tack Coat: Diluted cationic emulsified asphalt per Section 94, "Asphaltic Emulsions", of the State Standard Specification. Asphaltic emulsion shall be Grade CSS1h setting type.
 - 3. Reclaimed Asphalt Pavement (RAP): Processed material obtained by milling or full depth removal of existing asphalt paving.
- D. Reclaimed Asphalt Pavement (RAP) aggregate may be substituted for a part of virgin aggregate in a quantity not to exceed fifteen percent (15%) by weight of the aggregate blend.
- 1. RAP shall conform to Section 39-2.02A(3)(c), "Reclaimed Asphalt Pavement", of the State Standard Specifications.
 - 2. During Type A HMA production, sample RAP twice daily and perform QC testing for:
 - a. Aggregate gradation at least once a day under California Test 384.
 - b. Moisture content at least twice a day.
 - 3. If RAP is used, RAP quality requirements must be as shown in the following table.

Reclaimed Asphalt Pavement Quality

Quality Characteristic	Test method	Requirement
Binder Content (% within the average value reported)	AASHTO T 164	± 2.00
Specific Gravity (within the average value reported)	AASHTO T 209	± 0.06

- E. Aggregate Materials:
- 1. Coarse Aggregate: ASTM D692; Aggregate retained on a no. 4 sieve. crushed stone or gravel.
 - 2. Fine Aggregate: ASTM D1073, AASHTO M29; Aggregate passing a no. 4 sieve. Natural sand or sand manufactured from stone or gravel.
 - 3. Mineral Filler: finely ground mineral particles, free of foreign matter consisting of rock dust, slag dust, hydrated lime, hydraulic cement, or any combination of these and complying with AASHTO M17. Mineral fillers shall only be used if needed to improve the workability of the mix or gradation of the aggregate.
 - 4. The aggregate gradation for Type A HMA must comply with the requirements shown in the following table unless specified otherwise on the Drawings:

Aggregate Gradation Requirements

Type A HMA pavement thickness shown	Gradation
Greater than 0.10 to less than 0.20 foot	1/2 inch
0.20 to less than 0.25 foot	3/4 inch
0.25 foot or greater	3/4 inch

5. The top 0.20-foot layer of asphalt pavement on the roadway shall have an aggregate gradation of 1/2" inch maximum.
6. Aggregate gradation must be within the Target Value (TV) limits for the specified sieve size shown in the following tables:

**Aggregate Gradation for Type A HMA (percentage passing)
1 inch**

Sieve Size	Target value limit	Allowable tolerance
1"	100	-
3/4"	88-93	TV ± 5
1/2"	72-85	TV ± 6
3/8"	55-70	TV ± 6
No. 4	35-52	TV ± 7
No. 8	22-40	TV ± 5
No. 30	8-24	TV ± 4
No. 50	5-18	TV ± 4
No. 200	3-7	TV ± 2.0

3/4 inch

Sieve Size	Target value limit	Allowable tolerance
1"	100	-
3/4"	90-98	TV ± 5
1/2"	70-90	TV ± 6
No. 4	42-58	TV ± 5
No. 8	29-43	TV ± 5
No. 30	10-23	TV ± 4
No. 200	2-7	TV ± 2.0

1/2 inch

Sieve Size	Target value limit	Allowable tolerance
3/4"	100	-
1/2"	95-98	TV ± 5
3/8"	72-95	TV ± 5
No. 4	52-69	TV ± 5
No. 8	35-55	TV ± 5
No. 30	15-30	TV ± 4
No. 200	2-8	TV ± 2.0

3/8 inch

Sieve Size	Target value limit	Allowable tolerance
3/4"	100	-
1/2"	95-98	TV ± 5
3/8"	72-95	TV ± 5
No. 4	52-69	TV ± 5
No. 8	35-55	TV ± 5
No. 30	15-30	TV ± 4
No. 200	2-8	TV ± 2.0

7. Before the additional of asphalt binder, the aggregates must comply with the quality requirements shown in the following table:

Quality characteristics	Test Method	Requirement
Aggregate Gradation ^a	AASHTO T27	JMF ± Tolerance
Percent of crushed particles Coarse aggregate (min, %) One-fractured face Two-fractured face Fine aggregate (min, %) Passing No. 4 sieve and retained on No. 8 sieve.) One-fractured face	AASHTO T 335	95 90 70
Los Angeles Rattler (max, %) Loss at 100 Rev. Loss at 500 Rev.	AASHTO T96	12 40
Sand equivalent (min.) ^{b, c}	AASHTO T176	47
Flat and elongated particles (max, % by weight at 5:1)	ASTM D4791	10
Fine aggregate angularity (min, %) ^d	AASHTO T304, Method A	45
<p>^aThe Project Manager determines combined aggregate gradations containing RAP under California Test 384.</p> <p>^bReported value must be the average of 3 tests from a single sample.</p> <p>^cUse of a sand reading indicator is required as shown in AASHTO T176, Figure 1. Section 4.7, "Manual Shaker", 7.1.2, "Alternate Method No.2." and 8.4.3, "Hand Method," do not apply. Prepare the stock solution as specified in section 4.8.1, "Stock solution with formaldehyde," except omit the addition of formaldehyde.</p> <p>^dThe Project Manager waives this specification if HMA contains 10 percent or less of nonmanufactured sand by weight of total aggregate. Manufactured sand is fine aggregate produced by crushing rock or gravel.</p>		

2.2 TYPE A HMA PRODUCTION

- A. Contractor shall test the quality characteristics of Type A HMA under the test methods and frequencies shown in the following table and provide results to the City:

Type A HMA Production Testing Frequencies

Quality Characteristic	Test method	Minimum testing frequency
Asphalt Binder	AASHT T 308, Method A	1 per 750 tons and any remaining part
HMA Moisture Content	AASHTO T 329	1 per 2,500 tons but not less than 1 per paving day
Air Void Content	AASHTO T 269	1 per 4,000 tons or 2 every 5 paving days whichever is greater
Voids in mineral aggregate	SP-2 Asphalt Mixture Volumetrics	1 per 10,000 tons or 2 per project whichever is greater
Dust proportion	SP-2 Asphalt Mixture Volumetrics	
Density of core	California Test 375	2 per paving day
Nuclear gauge density	California Test 375	3 per 250 tons or 3 per paving day, whichever is greater
Hamburg wheel track	AASHTO T 324 (Modified)	1 per 10,000 tons or 1 per project whichever is greater.
Moisture susceptibility	AASHTO T 283	

2.3 TYPE A HMA ACCEPTANCE

- A. In place Type A HMA quality requirements shall be as shown in the following table:

Type A HMA Acceptance In Place

Quality Characteristic	Test method	Requirement
Asphalt Binder content (%)	AASHTO T 308 Method A	JMF – 0.3, +0.50
HMA moisture content (max, %)	AASHTO T 329	1.00
Voids in mineral aggregate on laboratory-produced HMA (min, %) ^d Gradation: No. 4 3/8-inch 1/2-inch	SP-2 Asphaltic Mixture Volumetrics	16.5-19.5 15.5-18.5 14.5-17.5

3/4-inch 1-inch with NMAS = 1-inch with NMAS = 3/4-inch		13.5-16.5 13.5-16.5 14.5-17.5
Voids in mineral aggregate on plant-produced HMA (min, %) ^a Gradation: No. 4 3/8-inch 1/2-inch 3/4-inch 1-inch with NMAS = 1-inch with NMAS = 3/4-inch	SP-2 Asphaltic Mixture Volumetrics ^c	15.5-18.5 14.5-17.5 13.5-16.5 12.5-15.5 12.5-15.5 13.5-16.5
Dust proportion	SP-2 Asphaltic Mixture Volumetrics	0.6-1.3 ^g
Density of core (% of max theoretical density) ^{e,f}	California Test 375	91.0-97.0
Hamburg wheel track (min number of passes at 0.5-inch rut depth) Binder grade: PG 58 PG 64 PG 70 PG 76 or higher	AASHTO T 324 (Modified)	10,000 15,000 20,000 25,000
Hamburg wheel track (min number of passes at inflection point) Binder grade: PG 58 PG 64 PG 70 PG 76 or higher	AASHTO T 324 (Modified)	10,000 10,000 12,500 15,000
Moisture susceptibility (min, psi, dry strength)	AASHTO T 283	100
Moisture susceptibility (min, psi, wet strength)	AASHTO T 283	70
^a Prepare 3 briquettes. Report the average of 3 tests, ^b For CIP projects, the City's Testing Laboratory determines the bulk specific gravity of each lab-compacted briquette under AASHTO T 275, Method A, and theoretical maximum specific gravity under AASHTO T 209, Method A. ^c Determine the bulk specific gravity under AASHTO T 275, Method A. ^d For CIP projects, the City's Testing Laboratory determines the laboratory-prepared Type A HMA value for only mix design verification.		

^eFor CIP projects, the City's Testing Laboratory determines percent of theoretical maximum density under California Test 375 except for CIP Projects, City's Testing Laboratory uses:

1. AASHTO T 275 to determine in-place density of each density core.
2. AASHTO T 209, method A to determine theoretical maximum density instead of calculating test maximum density.

^fFor CIP projects, the City's Testing Laboratory determines theoretical maximum density under AASHTO T 209, Method A, at the frequency specified in California Test 375, part 5, section D.

^gFor lime-treated aggregates, the dust proportion requirement is 0.6-1.5

2.4 SOURCE QUALITY CONTROL

- A. [Section 01 45 00 - Quality Control](#): Testing, inspection and analysis requirements.
- B. Test samples in accordance with AI MS-2.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. [Section 01 70 00 - Execution](#): Requirements for installation examination.
- B. Verify utilities indicated under paving are installed with excavations and trenches backfilled and compacted.
- C. Verify compacted aggregate base is dry and ready to support paving and imposed loads as specified in the project Geotechnical Report or as directed by the Project Manager.
 1. Proof roll subbase with minimum two perpendicular passes to identify soft spots.
 2. Remove soft subbase and replace with compacted fill.
- D. Verify with a licensed land surveyor that the gradients and elevations of base are correct.
- E. Verify drainage grates and frames, and manhole frames are installed in correct position and elevation.

3.2 CONSTRUCTION

- A. Contractor may deposit HMA in a windrow and load it in the paver if:
 1. Paver is equipped with a hopper that automatically feeds the screed.

2. Loading equipment can pick up the windrowed material and deposit it in the paver hopper without contaminating or damaging HMA and subgrade base material.
 3. Activities for depositing, pickup loading and paving are continuous.
 4. HMA temperature in the windrow does not fall below 260-degree F.
- B. HMA placed in a windrow on the roadway surface must not extend more than 250 feet in front of the loading equipment or material transfer vehicle.
- C. HMA handled, spread, or windrowed must not stain the finished surface of any improvement, including pavement.
- D. Do not use petroleum products such as kerosene or diesel fuel to release HMA from trucks, spreaders, or compactors.
- E. HMA must be free of:
1. Segregation
 2. Coarse or fine aggregate pockets
 3. Hardened lumps
- F. Complete finish rolling activities before the pavement surface temperature is
1. Below 150 degrees F for HMA with unmodified binder
 2. Below 140 degrees F for HMA with modified binder

3.3 SPREADING AND COMPACTING EQUIPMENT

- A. Paving equipment for spreading must be:
1. Self-propelled
 2. Mechanical
 3. Equipped with a screed or strike-off assembly that can distribute HMA the full width of a traffic lane.
 4. Equipped with a full-width compacting device.
 5. Equipped with automatic screed controls and sensing devices that control the thickness, longitudinal grade, and transverse screed slope.
- B. Install and maintain grade and slope reference.
- C. The screed must be heated and produce a uniform HMA surface texture without tearing, shoving, or gouging.
- D. The paver must not leave marks such as ridges and indentations unless you can eliminate them by rolling.
- E. Rollers must be equipped with a system that prevents HMA from sticking to the wheels. You may use a parting agent that does not damage the HMA or impede the bonding of layers.

- F. In areas inaccessible to spreading and compacting equipment:
 - 1. Spread the HMA by any means to obtain the specified lines, grades and cross sections.
 - 2. Use a pneumatic tamper, plate compactor, or equivalent to achieve thorough compaction.

3.4 MATERIAL TRANSFER VEHICLE:

- A. The material transfer vehicle must have sufficient capacity to prevent stopping the paver and must be capable of:
 - 1. Either receiving HMA directly from trucks or using a windrow pickup head to load it from a windrow deposited on the roadway surface.
 - 2. Remixing the HMA with augers before transferring into the paver's receiving hopper or feed system.
 - 3. Transferring HMA directly into the paver's receiving hopper or feed system.

3.5 METHOD COMPACTION EQUIPMENT:

- A. For method compaction, each paver spreading HMA must be followed by 3 rollers:
 - 1. One vibratory roller specified designed to compact HMA. The roller must be capable of at least 2,500 vibrations per minute and must be equipped with amplitude and frequency controls. The roller's gross static weight must be at least 7.5 tons.
 - 2. One oscillating-type pneumatic-tired roller at least 4 feet wide. Pneumatic tires must be of equal size, diameter, type, and ply. The tires must be inflated to 60 psi minimum and maintained so that the air pressure does not vary more than 5 psi.
 - 3. One steel-tired, 2-axle tandem roller. The roller's gross static weight must be at least 7.5 tons.

3.6 SURFACE PREPARATION:

- A. Before placing HMA, remove loose paving particles, dirt, and other extraneous material by any means including flushing and sweeping.
- B. Prepare subgrade to receive HMA under the sections for the material involved. Subgrade must be free of loose and extraneous material.

3.7 TACK COAT:

- A. Apply tack coat in accordance with Section 39-2.01C(3)(f) of the State Standard Specifications.

- B. Apply tack coat:
 - 1. To existing pavement including planed surfaces.
 - 2. Between HMA layers
 - 3. To vertical surfaces of:
 - a. Curbs
 - b. Gutters
 - c. Construction joints.
- C. Coat surfaces of manholes and catch basins.
- D. Equipment for the application of tack coat must comply with Section 37-1.03B, "Equipment" of the State Standard Specifications.
- E. Before placing HMA, apply tack coat in one (1) application at the minimum residual rate shown in the following table for the condition of the underlying surface:

Tack Coat Application Rates for HMA

HMA Over:	Minimum residual rates (gal/sq. yd) CSS1/CSS1h asphaltic emulsion
New HMA (between layers)	0.02
Concrete Pavement and existing asphalt concrete surfacing	0.03
Planed pavement	0.05

- F. If a stress absorbing membrane interlayer as specified in Section 37-2.05, "Stress Absorbing Membrane Interlayers", of the State Standard Specification is applied, the tack application rates for new HMA apply.
- G. Notify the Project Manager if you dilute asphaltic emulsion with water. The weight ratio of added water to asphaltic emulsion must not exceed 1 to 1.
- H. Apply tack coat to vertical surfaces with a residual rate that will thoroughly coat the vertical face without running off.
- I. Immediately in advance of placing HMA, apply additional tack coat to damaged areas or where loose or extraneous material is removed.
- J. Close areas to traffic receiving tack coat. Do not allow the tracking of tack coat onto pavement surfaces beyond the job site.
- K. If an asphalt binder is used for tack coat, the asphalt binder temperature must be from 285 to 350-degree F when applied.

3.8 LONGITUDINAL JOINTS

- A. Longitudinal joints in the top layer must match lane lines. Alternate the longitudinal joint offsets in the lower layers at least 0.5 foot from each side of the lane line.
- B. A vertical longitudinal joint of more than 0.15 foot is not allowed at any time between adjacent open lanes to traffic.
- C. For an HMA thickness of 0.15 foot or less, the distance between the ends of the adjacent surfaced lanes at the end of each day's work must not be greater than can be completed in the following day of normal paving.
- D. For an HMA thickness greater than 0.15 foot, you must place HMA on adjacent travel way lanes or shoulder such that at the end of each work shift the distance between the ends of HMA layers on adjacent lanes is from 5 to 10 feet. Place additional HMA along the transverse edge at each lane's end and along the exposed longitudinal edges between adjacent lanes. Hand rake and compact the additional HMA to form temporary conforms. Place Kraft paper or other authorized release agent under the conform tapers to facilitate the taper removal when paving activities resume.
- E. If placing HMA against the edge of existing pavement, saw cut or grind the pavement straight and vertical the joint to the full depth and remove extraneous material.

3.9 MISCELLANEOUS AREAS AND DIKES

- A. Asphalt concrete for dikes shall be Type A, 3/8" maximum size aggregate.
- B. Prepare the areas to receive HMA for miscellaneous areas and dikes, including excavation, placing tack coat, and backfill as needed.
- C. Spread the HMA in miscellaneous areas in 1 layer and compact to the specified lines and grades.
- D. The finished surface must be:
 - 1. Textured uniformly
 - 2. Compacted firmly
 - 3. Without depressions, humps, and irregularities.

3.10 COMPACTION

- A. Rolling must leave the completed surface compacted and smooth without tearing, cracking, or shoving.

- B. If a vibratory roller is used as a finish roller, turn the vibrator off.
- C. If the surface to be paved is both in sunlight and shade, pavement surface temperatures are taken in the shade.
- D. Relative compaction will be determined by California Test 375.

3.11 PAVEMENT CRACK SEALING

- A. See [Section 32 12 17 – Asphalt Paving Rehabilitation](#) for Pavement Crack Sealing Specifications.

3.12 ASPHALT PAVING TOLERANCES

- A. [Section 01 45 00 - Quality Control](#): Tolerances.
- B. Flatness: Maximum variation of 1/8 inch measured with 10-foot straight edge.
- C. Scheduled Compacted Thickness: Within 1/4 inch.

3.13 FIELD QUALITY CONTROL

- A. [Section 01 45 00 – Quality Control](#): Requirements for testing, adjusting, and balancing.
- B. Asphalt Paving Mix Temperature: Measure temperature at time of placement.

3.14 PROTECTION

- A. [Section 01 77 00 - Closeout Requirements](#): Requirements for protecting finished Work.
- B. Immediately after placement, protect paving from mechanical injury for until surface temperature is less than 140 degrees F.

END OF SECTION 32 12 16

SECTION 32 12 17 - ASPHALT PAVEMENT REHABILITATION**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Asphalt materials.
2. Aggregate materials.
3. Type A HMA Asphalt paving
4. Tack coat
5. Cold Planing
6. Geosynthetic pavement interlayer
7. Crack treatment
8. Adjusting iron castings to grade
9. Surface slurry.
10. Micro-surfacing

B. Related Requirement:

1. [Section 32 11 23 - Aggregate Base Courses](#): Compacted subbase for paving.
2. [Section 33 05 13 - Manholes and Structures](#)

1.2 PRICE AND PAYMENT PROCEDURES

A. [Section 01 29 00 - Payment Procedures](#) Contract Sum/Price

B. Asphalt Paving or HMA:

1. Basis of Measurement: By ton and will be based on certified weight-meters certificates showing gross, net weight and the type and grading of the mix for each load.
2. Basis of Payment: Includes priming surfaces, tack coating surfaces, fog seal, furnishing, placing, compacting, and testing base course.

C. Cold Planing Asphalt Pavement:

1. Basis of Measurement: By Square foot.
2. Basis of Payment: Includes removing existing pavement markers, legends and pavement striping, removing detector loops, grinding or cold planing asphalt pavement to achieve a minimum 2-inch HMA thickness overlay, and preparing surface for HMA overlay.

3. If a separate bid item is not listed in the bid form for Monument Protection and Referencing, full compensation for referencing monuments, re-establishing the monuments and submitting corner record to the County by a Licensed Land Surveyor shall be considered as included in the price paid for Cold Planing Asphalt Pavement and no separate compensation will be allowed therefor.
4. If a separate bid item is not listed in the bid form for lowering of utilities and re-adjustment of utility boxes, valves, grates and manholes covers to finish grade after paving, full compensation for adjusting the utility boxes, valves, grates and manhole covers to finish grade shall be considered as included in the price paid for Cold Planing Asphalt Pavement and no separate compensation will be allowed therefor.

D. Geosynthetic Pavement Interlayer:

1. Basis of Measurement: By square yard of area measured from the actual pavement covered over the interlayer. If multiple layers of pavement interlayer are used, square footage of each layer would be added for the measurement.
2. Basis of Payment: Includes priming surfaces, tack coating surfaces, furnishing, placing, overlapping and compacting.

E. Crack Treatment:

1. Basis of Measurement: Crack treatment will be measured per lineal foot, unless specified otherwise in the Contract Documents.
Basis of Payment: Crack treatment is considered incidental to the item most closely related to and no separate compensation will be allowed therefor.

F. Slurry seal:

1. Basis of Measurement: By square feet of area measured from the actual pavement covered by slurry seal application
2. Basis of Payment: Includes coordinating with utility companies, covering and protecting utility structures before and after slurry seal, sweeping, traffic controls, surface preparation, equipment inspections, applying slurry seal, rolling, clean up, and opening to traffic.

G. Micro-surfacing:

1. Basis of Measurement: By square feet of area measured from the actual pavement covered by Micro-surfacing application.
2. Basis of Payment: Includes coordinating with utility companies, covering and protecting utility structures before and after micro-surfacing, grade, sweeping, traffic controls, surface preparation, equipment inspections, applying micro-surfacing, rolling, clean up, and opening to traffic.

1.3 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:

1. AASHTO M17 - Standard Specification for Mineral Filler for Bituminous Paving Mixtures.
2. AASHTO M29 - Standard Specification for Fine Aggregate for Bituminous Paving Mixtures.
3. AASHTO M140 - Standard Specification for Emulsified Asphalt.
4. AASHTO M208 - Standard Specification for Cationic Emulsified Asphalt.
5. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications.
6. AASHTO M320 - Standard Specification for Performance-Graded Asphalt Binder.
7. AASHTO M324 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
8. AASHTO MP1a - Standard Specification for Performance-Graded Asphalt Binder.
9. AASHTO T283-14 – Standard Method of Test for Resistance of Compacted Asphalt Mixtures to Moisture-Induced Damage.
10. AASHTO T324 (Modified) -Hamburg Wheel-Track Testing of Compacted Hot Mix Asphalt (HMA).

B. Asphalt Institute:

1. AI MS-2 - Mix Design Methods for Asphalt Concrete and Other Hot- Mix Types.
2. AI MS-19 - Basic Asphalt Emulsion Manual.
3. AI SP-2 - Superpave Mix Design.

C. State Standard Specification:

1. Section 39 Asphalt Concrete.
2. Section 92 Asphalt Binders.
3. Section 94 Asphaltic Emulsions
4. Section 96 Geosynthetics

1.4 SUBMITTALS

A. [Section 01 33 00 - Submittal Procedures](#): Requirements for submittals.

B. Job Mix Formula (JMF): Except for the Hot Mix Asphalt (HMA) to be used in miscellaneous areas (median island areas not including inside shoulders, island areas, sidewalk, gutters, ditches, over side drains and aprons at end of drainage structures) and dikes, submit the proposed JMF for Type A HMA.

C. The JMF must be submitted on the Contractor Job Mix Formula Proposal form along with:

1. Mix design documentation on Contractor's Hot Mix Asphalt Design data form dated with 12 months of submittal.
 2. Safety Data Sheets (SDS) for the following:
 - a. Asphalt Binder
 - b. Supplemental fine aggregate except fines from dust collectors
 - c. Antistrip additives.
- D. The Contractor's Hot Mix Asphalt Design Data form must show documentation on aggregate quality.
- E. Submit QC test results for Reclaimed Asphalt Pavement (RAP) gradation with the combined aggregate gradation within 2 business days of taking RAP samples during Type A HMA production.
- F. Contractor shall submit a new JMF if there are changes to any of the following:
 1. Target asphalt binder percentage greater than ± 0.2 percent.
 2. Asphalt binder supplier
 3. Combined aggregate gradation
 4. Aggregate sources
 5. Liquid antistrip producer or dosage
 6. Average binder content in a new processed RAP stockpile by more than ± 2.0 percent from the average RAP binder content reported on Contractor Hot Mix Asphalt Design Data form.
 7. Average maximum specific gravity in a new processed RAP stockpile by more than ± 0.060 percent from the average maximum specific gravity value reported on Contractor's Hot Mix Asphalt Design Data form.
 8. Any material in the JMF.
- G. Submit a current asphalt concrete mix design from two separate sources (primary source and backup source) for asphalt concrete proposed to be used.
- H. For Capital Improvement Projects (CIP) projects, the Contractor shall provide delivery tickets to the City at the time of delivery of each load of product, including asphalt concrete, tack coat, sealant, and paving reinforcement fabric. Each delivery ticket shall include or be accompanied by appropriate batch information produced by the batching plant or factory of origin and information stating the mix or model number, total yield in tons, gallons, or square feet, and time, date, and location of delivery.
- I. Any asphalt concrete rejected by the Project Manager shall be deducted from the total quantity of asphalt concrete tonnage.
- J. Reference Plan: Contractor shall have a walk through with Engineer for all installed underground boxes and/or iron elements, ten (10) working days prior to any pavement repair. Contractor shall submit a reference plan (RP) for utility facilities adjustment prior to covering or lowering any utility facilities three (3) working days prior to any pavement repair.

- K. Submit a laboratory report of test results and a proposed mix design 10 days before starting placement of slurry seal. The report and mix design must include the specific materials to be used. The laboratory report must include:
 - 1. Test results used in the mix design
 - 2. Proportions of the following materials based on the aggregate's dry weight:
 - a. Aggregate
 - b. Filler determined from tests, minimum and maximum
 - c. Water, minimum and maximum
 - d. Asphalt solid content
 - e. Set control agent
 - 3. Comparison of slurry seal test results to the specified values

- L. Submit a laboratory report of test results and a proposed mix design 10 days before starting placement of micro-surfacing. The report and mix design must include the specific materials to be used. The laboratory report must include:
 - 1. Test results used in the mix design
 - 2. Proportions of the following materials based on the aggregate's dry weight:
 - a. Aggregate
 - b. Water, minimum and maximum
 - c. Additives
 - d. Mineral filler, minimum and maximum
 - e. Micro-surfacing emulsion residual asphalt content, minimum and maximum
 - 3. Recommend changes to the following proportions based on heating the mixture to 100-degree F and mixing for 60 seconds:
 - a. Water
 - b. Additives
 - c. Mineral Filler
 - 4. Comparison of each individual material's test results to its specified values.
 - 5. Quantitative moisture effects on the aggregate's unit weight determined under ASTM C29.

1.5 QUALITY CONTROL PLAN

- A. The Contractor shall submit a Quality Control (QC) plan for HMA.
- B. The QC plan shall describe the organization and procedures for:
 - 1. Controlling HMA quality characteristics
 - 2. Taking samples, including sampling locations.
 - 3. Establishing, implementing, and maintaining QC
 - 4. Determining when corrective actions are needed.
 - 5. Implementing corrective actions.
 - 6. Using methods and materials for backfilling core locations.
- C. The QC plan must address the elements affecting HMA Quality, including

1. Aggregates
2. Asphalt binder
3. Additives
4. Productions
5. Paving

- D. For CIP projects, the Contractor shall permit the City's certified testing laboratory to take samples of the aggregate and asphalt emulsion used in the project at the City's discretion. Gradation and sand equivalent tests may be run on the aggregate and residual asphalt tests on the emulsion. City will compare the test results with this Section and notify the Contractor if any test fails to meet specifications.
- E. The Contractor shall furnish all tools and equipment and employ sufficient trained personnel to operate all equipment and perform all handwork efficiently and skillfully.

1.6 AGGREGATES TESTING:

- A. Contractor shall test the quality of aggregates under the test methods and frequencies shown in [Section 32 12 16 – Asphalt Paving](#).

1.7 AMBIENT CONDITIONS

- A. Refer to [Section 32 12 16 – Asphalt Paving](#) for ambient air and surface temperatures for spreading HMA.

PART 2 - PRODUCTS

2.1 ASPHALT PAVING

- A. Asphalt Concrete shall conform to Section 39, "Asphalt Concrete", of the State Standard Specifications and the City Standard Specifications.
- B. Asphalt Concrete for surfacing shall be Hot Mix Asphalt (HMA) Type A.
- C. Asphalt Materials:
1. Asphalt Binder: Asphalt Binder must comply with Section 92, "Asphalt Binders", of the State Standard Specifications.
 - a. For a leveling course, the grade of the asphalt binder for the Hot mix asphalt (HMA) must be PG 64-10 or PG 64-16.
 - b. For Miscellaneous areas, and asphalt dikes the grade of the asphalt binder for the Hot mix asphalt (HMA) must be PG 70-10. Minimum

asphalt binder content must be 6.40 percent for 3/8” maximum size aggregate.

2. Tack Coat: Diluted cationic emulsified asphalt per Section 94, “Asphaltic Emulsion”, of the State Standard Specification. Asphaltic emulsion shall be Grade CSS1h setting type.
 3. Reclaimed Asphalt Pavement (RAP): Processed material obtained by milling or full depth removal of existing asphalt paving.
 4. Oil
- D. Reclaimed Asphalt Pavement (RAP) aggregate may be substituted for a part of virgin aggregate in a quantity not to exceed fifteen percent (15%) by weight of the aggregate blend.
1. RAP shall conform to Section 39-2.02A(3)(c), “Reclaimed Asphalt Pavement”, of the State Standard Specifications.
 2. During Type A HMA production, sample RAP twice daily and perform QC testing for:
 - a. Aggregate gradation at least once a day under California Test 384.
 - b. Moisture content at least twice a day.
 3. If RAP is used, RAP quality requirements must be as shown in the following table.

Reclaimed Asphalt Pavement Quality

Quality Characteristic	Test method	Requirement
Binder Content (% within the average value reported)	AASHTO T 164	± 2.00
Specific Gravity (within the average value reported)	AASHTO T 209	± 0.06

- E. Aggregate Materials: All aggregate materials shall conform to the aggregate material specifications specified in [Section 32 12 16 – Asphalt Paving](#).

2.2 TYPE A HMA PRODUCTION

- A. Contractor shall test the quality characteristics of Type A HMA under the test methods and frequencies shown in [Section 32 12 16 – Asphalt Paving](#).

2.3 TYPE A HMA ACCEPTANCE

- A. For Type A HMA quality requirements, see Type A HMA acceptance specified in [Section 32 12 16 – Asphalt Paving](#).

2.4 GEOSYNTHETIC PAVEMENT INTERLAYER:

- A. Geosynthetic pavement interlayer shall conform to Geosynthetic pavement interlayer specified in [Section 32 12 16 – Asphalt Paving](#).

2.5 CRACK TREATMENT:

- A. Crack sealant must comply with Section 37-6, “Crack Treatments”, of the State Standard Specifications.
- B. The pavement crack treatment material must comply with the requirements for Type 1 or Type 2 crack treatment material shown in the following table:

Crack Treatment Material

Quality characteristic ^a	Test method ^b	Requirements	
		Type 1	Type 2
Softening Point (min, °C)	ASTM D36/D36M	102	96
Cone Penetration at 77-degrees F (max)	ASTM D5329	35	40
Resilience at 77-degre F, unaged (% min)	ASTM D5329	20-60	25-65
Flexibility ^c (°C)	ASTM D3111	0	0
Tensile adhesion (min, %)	ASTM D5329	300	400
Specific Gravity (max.)	ASTM D70	1.25	1.25
Asphalt Compatibility	ASTM D5329	Pass	Pass
Sieve test (% passing)	See note d	100	100

^aCold-applied crack treatment material residue collected under ASTM D6943, Method B and sampled under ASTM D140 must comply with the grade specifications.

^bExcept for viscosity, cure each specimen at a temperature of 23 ± 2 °C and a relative humidity of 50 ± 10 percent for 24 ± 2 hours before testing.

^cFor the flexibility test, the specimen size must be 6.4 ± 0.2 mm thick by 25 ± 0.2 mm wide by 150 ± 0.5 mm long. The test mandrel diameter must be 6.4 ± 0.2 mm. The bend arc must be 180 degrees. The bend rate must be 2 ± 1 seconds. At least 4 of 5 test specimens must pass at the specified test temperature without fracture, crazing, or cracking.

^dFor hot-applied crack treatment, dilute with toluene and sieve through a no. 8 sieve. For cold-applied crack treatment, sieve the material as-received through a no. 8 sieve. If the manufacturer provides a statement that added components passed the no. 16 sieve before blending, this requirement is void.

- C. The material shall be capable of being melted and applied to cracks and joints at temperatures below 400-degrees F. When heated, it shall readily penetrate cracks 1/4-inch wide or wider.
- D. Crack treatment material must be delivered to the job site with manufacturer’s name, production location, brand or trade name, designation, crack treatment trade name, batch number, maximum heat temperature and expiration date for cold application only.
- E. Hot-applied crack treatment must be delivered to the job site premixed in cardboard containers with meltable inclusion liners or in a fully meltable package.
- F. Sand applied to tacky crack treatment material must be clean, free of clay, and comply with the gradation shown in the following table:

Sand Gradation

Sieve Size	Percent passing
No. 4	100
No. 50	0-30
No. 200	0-5

2.6 SLURRY SEAL

- A. Slurry Seal shall be in conformance with Section 37-3 – Slurry Seal and Micro-Surfacing of the State Standard Specifications.
- B. Applying slurry seal consists of spreading a mixture of asphaltic emulsion, aggregate, set-control additives, and water on a surface or pavement.
- C. Aggregates for slurry seal and micro-surfacing must comply with the gradation requirements shown in the following table:

Sand Gradation

Sieve Size	Percent passing (Class II)
3/8"	100
No. 4	94-100
No. 8	65-90
No. 16	40-70
No. 30	25-50
No. 200	5-15

- D. Aggregate must be rock dust or sand such as plaster sand. Aggregate larger than No. 50 sieve must be 100 percent crushed rock. Aggregate must be free from vegetable matter, deleterious substances, caked or clay clumps, and oversized particles.
- E. The mix design must have the percent of asphaltic emulsion, based on percentage by weight of the dry aggregate, within the range of 12%-18% for Class II aggregate type.
- F. Minimum sand equivalent per California Test 217 and minimum durability index and California Test 229 shall be 55 for Class II Aggregate.

2.7 MICRO-SURFACING

- A. Micro-surfacing shall be in conformance with Section 37-3, "Slurry Seal and Micro-surfacings", of the State Standard Specifications.
- B. Applying Micro-surfacing consists of spreading a mixture of micro-surfacing emulsion, water, additives, mineral filler and aggregate on the pavement.
- C. Micro-surfacing mix design must have the material proportion limits shown in the following table:

Micro-surfacing Mix Design Proportion Limits

Material	Proportion Limits
Micro-surfacing emulsion residual asphalt	5.5%-9.5% of aggregate by weight
Water and additives	No Limit
Mineral Filler	0%-3% aggregate dry weight

- D. Aggregate for micro-surfacing except mineral filler must comply with the requirements shown in the following table:

Micro-surfacing aggregate

Quality Characteristic	Test Method	Requirement
Sand equivalent (min.)	California Test 217	65
Durability index (min.)	California Test 229	65
Percentage of crushed particles (min., %) ^a	California Test 205	95
Los Angeles Rattler Loss at 500 revolutions (max, %) ^b	California Test 211	35
^a Crushed particles must have at least 1 fractured face		
^b California Test 211 must be performed on the aggregate before crushing.		

- E. Micro-surfacing emulsion must be a homogeneous mixture of asphalt, polymer, and emulsifier solution and shall conform to Section 37-3.03A(4)(b)(ii), "Micro-surfacing Emulsion", of the State Standard Specifications.
- F. If Portland cement is used as mineral filler, it must be any combination of Type I, Type II or Type II cement.

2.8 SOURCE QUALITY CONTROL

- A. [Section 01 45 00 - Quality Control](#): Testing, inspection and analysis requirements.
- B. Test samples in accordance with AI MS-2.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. [Section 01 70 00 - Execution](#) and [Section 01 77 00 - Closeout Requirements](#): Requirements for installation examination.
- B. Verify utilities indicated under paving are installed with excavations and trenches backfilled and compacted.
- C. Verify compacted aggregate base is dry and ready to support paving and imposed loads as specified in the project Geotechnical Report or as directed by the Project Manager.
 - 1. Proof roll subbase with minimum two perpendicular passes to identify soft spots.
 - 2. Remove soft subbase and replace with compacted fill.
- D. Verify with a licensed land surveyor that the gradients and elevations of base are correct.
- E. Verify drainage grates and frames, and manhole frames are installed in correct position and elevation.

3.2 DEMOLITION

- A. Saw cut and notch existing paving as indicted on Drawings. Before removing any portion of an asphalt concrete facility, make a sawcut full depth to a true line along the limits of the removal area.
- B. Clean existing paving to remove foreign material, excess joint sealant and crack filler from paving surface.

- C. Repair surface defects in existing paving to provide uniform surface to receive new paving.
- D. Where replace asphalt concrete surfacing is shown, remove the full depth of the existing asphalt concrete surfacing and replace with HMA.
- E. Before removing asphalt concrete, outline the replacement areas and cut neat lines with a saw or grind to full depth of on the existing asphalt concrete. Do not damage asphalt concrete and base that is to remain in place.
- F. Any excavations of the base material beyond the specified plane, shall be replaced with HMA. No additional compensation will be allowed for HMA placed beyond the specified plane.
- G. Do not use a material transfer vehicle for replacing asphalt concrete surfacing.
- H. When base and surfacing are described to be removed, remove base and surfacing to a depth of at least 6 inches below the grade of the existing surfacing. Backfill resulting holes and depressions.
- I. All material removed shall become the property of the Contractor and shall be disposed of in a legal manner.

3.3 COLD PLANING ASPHALT CONCRETE PAVEMENT

- A. Cold planning asphalt concrete pavement includes the removal of pavement markers, traffic stripe, and pavement markings within the area of cold planning.
- B. Cold plane existing asphalt paving to a minimum depth that results in a new HMA pavement section which is minimum 2-inch thick as shown on the Drawings. Contractor shall make a sawcut after cold planing at the conform edges to allow for a minimum 2-inch vertical surface at the conforms.
- C. HMA for temporary tapers must be of the same quality that is used for the HMA overlay.
- D. Do not use a heating device to soften the pavement.
- E. The cold planning machine must be:
 - 1. Equipped with a cutter head width that matches the planing width unless a wider cutter head is authorized
 - 2. Equipped with automatic controls for the longitudinal grade and transverse slope of the cutter head and:
 - a. If a ski device is used, it must be at least 30 feet long, rigid, and a 1-piece unit. The entire length must be used in activating the sensor.
 - b. If referencing from existing pavement, the cold planing machine must be controlled by a self-contained grade reference system. The system

- must be used at or near the centerline of the roadway. On the adjacent pass with the cold planing machine, a joint matching shoe may be used.
3. Equipped to effectively control dust generated by the planing operation.
 4. Operated such that no fumes or smoke is produced.
- F. Replace broken, missing, or worn machine teeth.
- G. If the Contractor does not complete placing the HMA surfacing before opening the area to traffic, the Contractor must:
1. Construct a temporary HMA taper to the level of the existing pavement
 2. Place HMA during the next work shift
 3. Submit a corrective action plan that shows that the Contractor will complete cold planing and placement of HMA in the same work shift. Do not restart cold planing activities until the corrective action plan is authorized.
- H. The completed surface of the planed pavement must not vary more than 0.02 foot when measured with a 12-foot straightedge parallel with the centerline. With the straightedge at right angles to the centerline, the transverse slope of the planed surface must not vary more than 0.03 foot.
- I. Where lanes are open to traffic, the drop-off between adjacent lanes must not be more than 0.15 foot.
- J. Remove cold planed material concurrently with planing activities such that the removal does not lag more than 50 feet behind the planer. All materials removed shall become the property of the Contractor and shall be disposed of in a legal manner.
- K. The Contractor shall be responsible for maintaining the street in a clean condition during the course of the cold planing or grinding operations using a vacuum sweeper.
- L. If a drop-off between the existing pavement and the planed areas at transverse joints cannot be avoided before opening to traffic, construct a temporary HMA taper. The HMA temporary taper must be:
1. Placed to the level of existing pavement and tapered on a slope of 30:1 (horizontal: vertical) or flatter to the level of the planed areas.
 2. Compacted by any method that will produce a smooth riding surface.
- M. Completely remove temporary tapers before placing permanent surfacing.
- N. Remove and replace any traffic signal detector loops and loop conductors including the loop conductors leading into the detector box. For City owned traffic signals where traffic signal detector loops are present, the Contractor shall notify the Project Manager a minimum of one (1) week prior to beginning work near the loops. For Caltrans traffic signals the Contractor shall notify Caltrans in conformance with Caltrans requirements.

3.4 CONSTRUCTION

- A. Refer to [Section 32 12 16 - Asphalt Paving](#) for construction of asphalt paving.

3.5 SPREADING AND COMPACTING EQUIPMENT

- A. Refer to [Section 32 12 16 - Asphalt Paving](#) for construction of compaction of asphalt paving.

3.6 MATERIAL TRANSFER VEHICLE:

- A. Refer to [Section 32 12 16 - Asphalt Paving](#) for material transfer vehicle.

3.7 METHOD COMPACTION EQUIPMENT:

- A. Refer to [Section 32 12 16 - Asphalt Paving](#) for material method compaction equipment.

3.8 SURAFCE PREPARATION:

- A. Refer to [Section 32 12 16 - Asphalt Paving](#) for surface preparation and tack coat.

3.9 GEOSYNTHETIC PAVEMENT INTERLAYER

- A. Where shown on Drawings, place geosynthetic pavement interlayer over a coat of asphalt binder and in compliance with the manufacturer's instructions. Do not place the interlayer on a wet or frozen surface.
- B. Before placing the interlayer and asphalt binder:
 - 1. Repair cracks 1/4-inch and wider, spalls, and holes in the pavement. Repairing cracks is not change order work.
 - 2. Clean the pavement of loose and extraneous material.
- C. Immediately before placing the interlayer, apply 0.25 ± 0.03 gal of asphalt binder per square yard of interlayer or until saturated. Apply asphalt binder the width of the interlayer plus 3 inches on each side. At an overlap, apply asphalt binder on the lower interlayer the same overlap distance as the upper interlayer.
- D. Align and place the interlayer with no overlapping wrinkles, except a wrinkle that overlaps may remain if it is less than 1/2-inch thick. If the overlapping wrinkle is more than 1/2-inch thick, cut the wrinkle out and overlap the interlayer no more than 4 inches.

- E. Overlap the interlayer borders between 4 to 6 inches. In the direction of paving, overlap the following roll with the preceding roll at any break.
- F. Use rolling equipment to correct distortions or wrinkles in the interlayer.
- G. If asphalt binder tracked onto the interlayer or brought to the surface by construction equipment causes interlayer displacement, cover it with a small quantity of HMA.
- H. Before placing HMA on the interlayer, do not expose the interlayer to:
 - 1. Traffic except for crossings under traffic control and only after you place a small HMA quantity.
 - 2. Sharp turns from construction equipment
 - 3. Damaging elements.
- I. Pave HMA on the interlayer during the same work shift. The minimum HMA thickness over the interlayer must be 0.17-foot thick including at pavement conforms as shown on the drawings.

3.10 LONGITUDINAL JOINTS

- A. Refer to [Section 32 12 16 - Asphalt Paving](#) for longitudinal joints.

3.11 WIDENING EXISTING PAVEMENT

- A. If widening existing pavement, construct new pavement structure to match the elevations of the existing pavement's edge before placing HMA over the existing pavement.

3.12 COMPACTION

- A. Refer to [Section 32 12 16 - Asphalt Paving](#) for compaction.

3.13 PAVEMENT CRACK SEALING

- A. Prior to overlaying existing pavements, crack sealing operations shall be performed in accordance with the following:
 - 1. Crack sealing shall be performed on all pavement cracks 1/4-inch wide or wider. Cracks between 1/4-inch and 1/2-inch wide shall be routed to a depth and width of 1/2-inch prior to sealing.
 - 2. Fill or repair cracks wider than 1-inch or as shown on the Drawings.
 - 3. Crack sealing shall be performed after any required pavement repair or grinding operations and prior to placing flexible pavement coatings, pavement reinforcing fabric, or overlay.

4. All pavement cracks not routed shall first be treated for weed prevention.
5. For hot-applied crack treatment material, rout cracks or sawcut to form a reservoir.
6. Immediately prior to performing crack sealing, the cracks shall be cleaned by the use of oil-free compressed air at a pressure of at least 90 psi such that all vegetation, dirt, and other objectionable materials are removed. The compressed air shall be filtered of moisture and oils. Under damp conditions, a hot compressed air lance shall be utilized to dry the cracks as well. The hot air lance must not apply flame directly on the pavement.
7. Crack sealant material shall conform to the provisions of PART 2 "Products" of this Section and shall be applied at the temperature and rate recommended by the manufacturer.
8. Apply crack treatment with a nozzle inserted into the crack. Fill the crack flush. If after 2 days the crack treatment is more than 1/4-inch below the specified level, the sealant fails, or the crack re-opens, re-treat the crack.
9. Extensively cracked pavement areas shall not be crack sealed unless specifically directed by the Project Manager. This is necessary to avoid interference with proper adhesion of the flexible pavement coatings, pavement reinforcing fabric, or overlay, and to avoid subsequent asphalt bleeding on the new surface. Where the Project Manager determines excessive coating or thickness of pavement crack sealant by the Contractor, the Contractor shall perform the necessary pavement base repairs at the Contractor's expense to correct the problem prior to placement of any flexible pavement coating, pavement reinforcing fabric, or overlay.
10. Immediately remove crack treatment material that is spilled or deposited on the pavement surface.
11. Crack seal areas shall be protected from traffic until the material has sufficiently cured and does not track. Any damage or loss of material from freshly placed crack seal material shall be replaced by the Contractor.
12. Before opening to traffic, apply sand or the manufacturer's recommended detackifying agent to tacky crack treatment material on the traveled way. Sweep up excess sand before opening to traffic.

3.14 ADJUST IRON CASTINGS TO GRADE

- A. Before applying slurry seal or micro-surfacing, cover manholes, valves and monument covers, grates or other exposed facilities located within the area of application using plastic or oil resistant construction paper secured by tape or adhesive to the facility being covered. Reference the covered facilities with enough control points to locate the facilities after application of the seal coat.
- B. All Iron Castings shall be set to finish grade after placing the asphalt concrete. The adjustment of structures and monuments to grade shall be in conformance with Section 15, "Existing Facilities," of the State Standard Specifications and this Section.

- C. When streets are overlaid unless deemed unsuitable by the Project Manager, existing frames and covers shall be salvaged and re-used. All iron castings damaged during construction shall be replaced by the Contractor with new iron castings at the Contractor's expense. Replacement iron castings for City utility structures shall be replaced in conformance with the appropriate technical section. Replacement iron castings for other Agency utility structures shall be replaced in conformance with the appropriate Agency requirements.
- D. All water valve covers shall be exposed on the same day in which they are covered by resurfacing operations.
- E. All maintenance hole covers shall be raised no later than 2 working days after resurfacing is placed, and shall be patch-paved with asphalt concrete within 2 working days after being raised.
- F. Tops of frames shall be set flush with finish grade. Frames which are not flush with finish grade shall be re-adjusted by the Contractor at the Contractor's expense.
- G. After adjusting frames Contractor shall ensure all covers are removable and seat properly when replaced. For new iron castings the new covers shall not rock.
- H. Hand mixing of concrete for use in raising iron castings to grade will be allowed. Concrete shall be placed and thoroughly consolidated in conformance with [Section 32 13 13 - Concrete Surface Improvements](#).
- I. The contractor shall place a false bottom in manholes and valve boxes prior to starting any work. The contractor is to remove any debris with a vacuum cleaner and remove the false bottom after paving. False bottom is to be constructed of 1" marine grade moisture-resistant plywood or City approved equal. The plywood is cut to a circle or otherwise shaped to fit the bottom of the manhole or valve box and then cut in half. The false bottom is then placed in the manhole or valve box with the seam crossing the flow or in such a manner to protect the sewer system from any debris. False bottom is to be placed on blocks at a minimum of 1" above all inlets to the manhole. False bottom shall be connected to the blocks via nails or staples to prevent the blocks from falling into the flow. Blocks shall not obstruct any part of the flow. All debris shall be removed from manhole prior to constructing false bottom. All debris shall be removed from manhole each time the manhole is worked on. False bottoms must be approved by the City prior to installations.
- J. Asphalt concrete patch paving shall be 1/2" maximum asphalt concrete placed over a tack coat. Patch paving may be placed by hand using a vibratory plate compactor or roller in conformance with this Section.

3.15 SLURRY SEAL & MICRO-SURFACING

- A. Proportion slurry seal ingredients in compliance with the authorized mix design. Proportion and blend different aggregate types before adding other ingredients. After proportioning, the slurry seal mixture must be workable.
- B. Proportion the micro-surfacing materials using the authorized mix design. Field conditions may require adjustments to the proportions during construction. Obtain Project Manger's written authorization before adjusting proportions.
- C. Before placing slurry seal or micro-surfacing, clean the pavement surface by removing loose particles of extraneous materials, including paving and dirt. Use any nondestructive methods, such as flushing and sweeping, cleaning any oil spots.
- D. If the slurry seal and micro-surfacing activities affect access to public parking, residential property or commercial property, business; notify residents, businesses, and utility companies at least 48 hours before starting activities, The notice must:
 - 1. Describe the work to be performed
 - 2. Detail streets and limits of activities
 - 3. Indicate work hours
 - 4. Be authorized by the Project manager
 - 5. Have an emergency contact information for the Contractor.
- E. Before starting slurry seal and micro-surfacing activities, post signs at 100-foot intervals on the affected streets. Signs must display *No Parking-Tow Away*. Signs must state the day of the week and hours parking or access will be restricted. Signs when no longer required shall be removed.
- F. Place slurry seal and micro-surfacing of both the pavement and air temperatures are at least 50 degrees F. Do not place Slurry or micro-surfacing if either the pavement or air temperature is below 50-degree F and falling. The expected high temperature must be at least 65 degrees F within 24 hours after placement.
- G. Do not place slurry seal or micro-surfacing if rain is imminent or the air temperature is expected to be below 36 degrees F within 24 hours after placement.
- H. Longitudinal joint must correspond with lane lines. Spread slurry in full lane widths.
- I. Longitudinal and transverse joints must be uniform, straight, neat in appearance, butt-type joints, without material buildup, and without uncovered areas.
- J. Spread slurry seal uniformly within the spread rate range of 10 to 15 lbs. of dry aggregate per square yard for Class II aggregate. Do not spot, rehandle or shift the mixture.

- K. Coat the pavement surface with CSS grade asphaltic emulsion mixed with additional water. The ratio of water to asphaltic emulsion must be 3 to 1. Apply the tack coat at a rate from 0.08 to 0.15 gal/sq. yd.
- L. The slurry seal mixture must be uniform and homogenous after spreading, and there must not be separation of the emulsion and aggregate after setting.
- M. The slurry seal surface must be cured to allow traffic without pilot cars within 1 hour after placement. The slurry seal must not show bleeding, raveling, separation, or other distresses for 15 days after placing.
- N. Protect the slurry seal from damage until it has cured and will not adhere or picked up by vehicle tires.
- O. Before micro-surfacing, fog the roadway surface with water ahead of the spreader box. The fog spray must be adjusted for pavement temperature, surface texture and dryness.
- P. The completed spread rate must be within 10 percent of the specified spread rate. The micro-surfacing spread rates must be within the ranges shown in the following table:

Micro-surfacing Spread Rates

Micro-surfacing type	Location	Range (lbs. of dry aggregate per sq. yd.)
Type II	Full lane width	10-20
Type III ^a	Full lane width	20-32

^aOver asphalt concrete pavement

- Q. Spread micro-surfacing either in the direction of traffic or in the opposite direction.
- R. Finished micro-surfacing must be free of irregularities such as scratch or tear marks. Do not leave any marks that are over 1-inch wide or 6-inches long.
- S. Sweep the micro-surfacing 24 hours after the placement without damaging the micro-surfacing. For 5 days afterward, sweep the micro-surfacing daily.
- T. If bleeding, raveling, delaminating, rutting, or wash-boarding occurs after placing the micro-surfacing make repairs as approved by the Project Manager.
- U. Sidewalk and driveways must be kept clean with an air compressor after 1st and 5th day of sweeping.

3.16 ASPHALT PAVING TOLERANCES

- A. [Section 01 45 00 – Quality Control](#): Tolerances.
- B. Flatness: Maximum variation of 1/8 inch measured with 10-foot straight edge.
- C. Scheduled Compacted Thickness: Within 1/4 inch.

3.17 FIELD QUALITY CONTROL

- A. [Section 01 45 00 – Quality Control](#): Requirements for testing, adjusting, and balancing.
- B. Asphalt Paving Mix Temperature: Measure temperature at time of placement.

3.18 PROTECTION

- A. [Section 01 77 00 - Closeout Requirements](#): Requirements for protecting finished Work.
- B. Immediately after placement, protect paving from mechanical injury for until surface temperature is less than 140 degrees F.

END OF SECTION 32 12 17

SECTION 32 13 13 - CONCRETE SURFACE IMPROVEMENTS**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Aggregate base course.
2. Concrete Surface Improvements for:
 - a. Concrete sidewalks
 - b. Concrete driveways
 - c. Concrete curb ramps
 - d. Concrete curbs and gutters
 - e. Concrete retaining curbs
 - f. Concrete median curbs
 - g. Concrete median nose surfacing
 - h. Concrete valley gutters
 - i. Concrete bus turnouts
 - j. Concrete survey monuments
 - k. Concrete ditches
3. Forms for Concrete
4. Concrete reinforcement (reinforcing bars, welded wire fabric and accessories).
5. Portland Cement Concrete placement
6. Concrete Joints - Expansion, Weakened plane and Score joints
7. Curing compounds

B. Related Requirements:

1. [Section 09 90 00 - Painting and Coating](#): Pavement markings.
2. [Section 31 05 13 - Clearing & Grubbing, Excavation, and Earthwork](#)
3. [Section 32 11 23 - Aggregate Base Courses](#)
4. [Section 32 12 16 - Asphalt Paving](#)
5. [Section 33 05 13 - Manholes and Structures](#)

1.2 PRICE AND PAYMENT PROCEDURES

A. [Section 01 29 00 - Payment Procedures](#)

B. Aggregate Base Course:

1. Basis of Measurement: Not measured.

2. Basis of Payment: Incidental to measurement for concrete surface improvements and includes supplying fill material, stockpiling, scarifying substrate surface, placing where required, and compacting.

C. Concrete Surface Improvements:

1. Basis of Measurement: By square feet for sidewalks, driveways, curb ramps, valley gutters, bus turnouts, trash enclosure pads and median nose surfacing; By linear feet for curb & gutter, concrete retaining curbs, and median curbs. Concrete pads around utility facilities and miscellaneous concrete footings are incidental to the bid item most closely related to and no separate compensation allowed therefor. Truncated domes for curb ramps are not measured separately are considered incidental to the pay item for Curb Ramps. Retaining curbs at curb ramps are not measured and are considered incidental to the measurement of curb ramps. Curb and gutter and vertical curbs adjacent to the curb ramp will be measured separately. Concrete Survey Monuments shall be measured on a per unit basis.
2. Basis of Payment: Includes all labor, materials, tools, equipment, and incidentals including subgrade preparation, excavation, base preparation, forms, reinforcing, concrete, accessories, placing concrete, finishing concrete, expansion joints, weakened plane joints, scoring joints, curing, removal of all forms, and testing.

1.3 REFERENCE STANDARDS

A. State of California (Caltrans) Standards:

1. Section 19 Earthwork
2. Section 26 Aggregate Base
3. Section 51 Concrete Structures
4. Section 52 Reinforcement
5. Section 73 Concrete Curbs and Sidewalks
6. Section 90 Concrete

B. American Association of State Highway and Transportation Officials:

1. AASHTO M295 - Standard Specification for Coal Fly Ash or Calcined Natural Pozzolan for Use in Concrete.
2. AASHTO M302 – Standard Specification for Ground Blast-Furnace Slag for Use in Concrete and Mortars
3. AASHTO T160 - Standard Method of Test for Length Change of Hardened Hydraulic Cement Mortar and Concrete

C. American Concrete Institute:

1. ACI 117 - Specifications for Tolerances for Concrete Construction and Materials.
 2. ACI 301 - Specification for Structural Concrete
 3. ACI 304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete.
 4. ACI 308.1 - Specification for Curing Concrete.
 5. ACI 347 – Guide to Formwork for Concrete
- D. American Forest & Paper Association:
1. AF&PA - National Design Specification (NDS) for Wood Construction.
- E. APA - The Engineered Wood Association:
1. APA/EWA PS 1 - Voluntary Product Standard - Structural Plywood.
- F. ASTM International:
1. ASTM A185 - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
 2. ASTM A497 - Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.
 3. ASTM A615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 4. ASTM A775 - Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
 5. ASTM A1064 - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
 6. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 7. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 8. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
 9. ASTM C143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
 10. ASTM C150 - Standard Specification for Portland Cement.
 11. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete.
 12. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete.
 13. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
 14. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
 15. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
 16. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 17. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
 18. ASTM C595 - Standard Specification for Blended Hydraulic Cements.

19. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
20. ASTM C979 - Standard Specification for Pigments for Integrally Colored Concrete.
21. ASTM C989 - Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars.
22. ASTM C1017 - Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
23. ASTM C1064 - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
24. ASTM D209 - Standard Specification for Lampblack Pigment
25. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).

G. Concrete Reinforcing Steel Institute:

1. CRSI 10-MSP – Manual of Standard Practice
2. CRSI 10PLACE – Placing Reinforcing Bars

H. West Coast Lumber Inspection Bureau:

1. WCLIB - Standard No. 17 Grading Rules for West Coast Lumber.

1.4 SUBMITTALS

A. [Section 01 33 00 - Submittal Procedures](#): Requirements for submittals.

B. Product Data:

1. Submit data on concrete materials, joint filler, joint sealants, admixtures, curing compounds.
2. Submit certified copies of mill test report of reinforcement materials analysis. Indicate bending and cutting schedules and supporting and spacing devices.
3. Submit manufacturer's information on curing compounds. Submit detailed instructions on installation requirements, including storage and handling procedures.
4. Shop drawings indicate formwork, shoring and reshoring.

C. Design Data:

1. Submit concrete mix design for each concrete strength. Submit separate mix designs when admixtures are required for the following:
 - a. Hot and cold weather concrete work.

2. Identify mix ingredients and proportions, including admixtures.
3. Chloride can contribute to corrosion of metals embedded in concrete. Admixture manufacturers shall identify chloride content of admixtures and whether or not chloride was added during manufacture.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

E. Source Quality Control Submittals: Indicate results of factory tests and inspections.

F. Certifications:

1. At the time of delivery provide certificates of compliance signed by both the Contractor and Supplier to verify the following:
 - a. Materials supplied comply with the specification in all respects.
 - b. Proportioning and mixing is in compliance with a design mix which has been field tested in accordance with the herein requirements and produces the required compressive strength under like conditions.
 - c. Statement of type and amount of admixtures.
 - d. All Certificates shall include the Material and Supplier's mix design number.
 - e. Volume of concrete. At the time of delivery provide certified delivery ticket stating volume of concrete delivered and time of mixing, or time of load-out in case of transit mixers.

1.5 QUALITY ASSURANCE

- A. Perform Work according to ACI 301.
- B. Obtain cementitious materials from same source throughout unless approved by the City.
- C. Concrete finish shall be consistent with adjacent concrete unless specified otherwise on the Drawings.
- D. For wood products furnished for Work of this Section, comply with AF&PA.

1.6 MOCKUP

- A. [Section 01 45 00 - Quality Control](#): Requirements for mockup.

- B. Construct mockup, 5 feet x 5 feet, including paving, expansion joints, weakened plane joints, score joints, surface texture, and base material for decorative colored concrete work.
- C. Locate where directed by the Project Manager.
- D. Remove mockup when directed by Project Manager.

1.7 AMBIENT CONDITIONS

- A. [Section 01 50 00 - Temporary Facilities and Controls](#): Ambient conditions control facilities for product storage and installation.
- B. Do not place concrete when surface is wet or frozen.
- C. Do not place concrete when base surface temperature is less than 45 degrees F, nor when conditions indicate that the temperature may fall less than 45 degrees F. within 24 hours, except with the written permission of the City Engineer. Salt chemicals, or other foreign materials shall not be mixed with the concrete for the purpose of preventing freezing. Concrete shall be effectively protected from freezing or frost for period of 5 days after placing.
- D. Concrete for structures shall not be mixed or placed while the ambient temperature is above 110 degrees F. unless adequate means are employed to cool the aggregate and water and satisfactory provisions have been made for protecting the work.

PART 2 - PRODUCTS

2.1 AGGREGATE BASE COURSE

- A. Aggregate Base: 3/4" maximum - Class 2 Aggregate Base as specified in Section 32 11 23 - Aggregate Base Courses.

2.2 CONCRETE SURFACE IMPROVEMENTS

- A. Form Materials:
 - 1. Form Materials: Conform to ACI 301 and shall be new.
 - 2. Plywood:
 - a. Species: Douglas fir.
 - b. Grade: Solid one side
 - c. Edges: Clean and true.
 - 3. Plywood Forms:
 - a. Application: Exposed finish concrete.

- b. Description:
 - 1) Comply with APA/EWA PS 1.
 - 2) Panels: Full size, 4 by 8 feet.
 - 3) Label each panel with grade trademark of APA/EWA.
 - c. Plywood for Surfaces to Receive Membrane Waterproofing:
 - 1) Minimum Thickness: 5/8 inch.
 - 2) Grade: APA/EWA "B-B Plyform Structural I Exterior."
- 4. Formwork shall be designed for the loads and lateral pressure outlined in Section 102 of ACI 347 and other loads indicated and shall be designed to have sufficient strength to carry the dead weight of the concrete as a liquid, without appreciable deflection. If any such deflection occurs, it shall be sufficient cause for rejection of the work.
 - 5. Where necessary to maintain the tolerances indicated, the formwork shall be cambered to compensate for anticipated deflections due to the weight and pressure of the fresh concrete and due to construction loads.
 - 6. Forms shall be smooth, mortar-tight, true to the required lines and grades and of sufficient strength to resist springing out of shape during the placing of concrete.
 - 7. Surfaces of forms shall be free from irregularities, dents, snags, rust, and other material which would discolor or transfer to the concrete.
- B. Reinforcement:
- 1. Deformed Reinforcing: Steel: ASTM A615, 60 ksi yield grade, deformed billet bars, uncoated finish.
 - 2. Welded Deformed Wire Fabric: ASTM A497; in [flat sheets] [coiled rolls]; [unfinished] [epoxy coated finish].
 - 3. Dowels: ASTM A615; 60 ksi yield strength, plain steel bars; cut to length indicated on Drawings, square ends with burrs removed; unfinished. One end of the dowel shall include a sleeve over the dowel.
 - 4. Tie Wire: ASTM A1064, Minimum 16 gage, black annealed type.
 - 5. Chairs, Bolsters, Bar Supports, and Spacers:
 - a. Size and Shape: To strengthen and support reinforcement during concrete placement conditions.
 - 1. Splicing: Splice reinforcing where indicated on Drawings. The length of lapped splices shall be as follows:
 - a. Reinforcing bars No. 8, or smaller, shall be lapped at least 45 bar diameters of the smaller bar joined, except when otherwise shown on the Drawings.
 - b. Reinforcing bars No. 9, 10 and 11 shall be lapped at least 60 bar diameters of the smaller bars joined, except when otherwise shown on the Drawings.
 - c. If not indicated on Drawings, locate reinforcement splices at point of minimum stress. Obtain approval of splice locations from the City.
 - 2. Reinforcing bars shall be free of mortar, oil, dirt, excessive mill scale and scabby rust and other coatings of any character that would destroy or

- reduce the bond. All bending shall be done cold, to the shapes shown on the Drawings.
3. Place, support, and secure reinforcement against displacement by using precast mortar blocks or ferrous metal chairs, spacers, metal hangers, supporting wires, and other approved devices of sufficient strength to resist crushing under applied loads. Supports and ties shall be such as to permit walking on reinforcing without undue displacement.
 4. Do not deviate from required position beyond specified tolerances.
 5. Accommodate placement of formed openings.
 6. Spacings:
 - a. Space reinforcement bars with minimum clear spacing as shown on the Drawings.
 - b. If bars are indicated in multiple layers, place upper bars directly above the lower bars, unless specified otherwise on the Drawings.
 7. Maintain minimum concrete cover around reinforcement according to ACI 318 code and as follows:
 - a. Footings and Concrete formed against earth: 3 inches
 - b. Concrete Exposed to Earth or Weather: 2 inches
 8. Splice reinforcing where indicated on Drawings. The length of lapped splices shall be as follows:
 - a. Reinforcing bars No. 8, or smaller, shall be lapped at least 45 bar diameters of the smaller bar joined, except when otherwise shown on the Drawings.
 - b. Reinforcing bars No. 9, 10 and 11 shall be lapped at least 60 bar diameters of the smaller bars joined, except when otherwise shown on the Drawings.
 9. All reinforcing shall be securely tied in place prior to pouring concrete.
 10. Placing of dowels or other reinforcing in the wet concrete is not permitted.
- C. Joint Filler: ASTM D1751; Premolded expansion joint filler 1/4-inch thick.
- D. Joint seal materials must be either silicone joint sealant, asphalt rubber joint sealant, or preformed compression joint seal. Silicone or asphalt rubber joint sealant must not bond or react with the backer rod.
- a. Silicone Joint Sealant. Silicone joint sealant must be on the Authorized Material List for silicone joint sealant.
 - b. Asphalt Rubber Joint Sealant. Asphalt rubber joint sealant must:
 - 1) Be asphalt binder mixed with not less than 10 percent ground rubber by weight. Ground rubber must be vulcanized or a combination of vulcanized and devulcanized materials that pass a no. 8 sieve.
 - 2) Comply with ASTM D6690 for Type II.
 - 3) Be capable of melting at a temperature below 400 degrees F and applied to cracks and joints.
 - 4) Be delivered in containers complying with ASTM D6690.
- E. Concrete Materials:

1. Cement: Cement shall conform to Section 90, "Concrete" of the State Standard Specifications.
2. Fine and Coarse Aggregates: Conform to the requirements of Section 90-1.02C, "Aggregates" of the State Standard Specifications. Size of aggregate for Portland cement concrete mix to be used for Survey monuments shall be 1/2-inch maximum.
3. Water: Conform to Section 90-1.02D, "Water" of the State Standard Specifications.
4. Air Entrainment: Air Entrainment admixtures shall meet the requirements of Section 90-1.02E(3), "Air-Entraining Admixtures" of the State Standard Specifications.
5. Chemical Admixture: Chemical admixtures shall meet the requirements of Section 90-1.02E(2), "Chemical admixtures" of the State Standard Specifications.
6. Supplementary Cementitious Materials - Fly Ash: Conform to the requirements of Section 90-1.02B(3), "Supplementary Cementitious Materials" of the State Standard Specifications.
7. Supplementary Cementitious Materials - Slag: Conform to the requirements of Section 90-1.02B(3), "Supplementary Cementitious Materials" of the State Standard Specifications.
8. Color Pigment: ASTM C979; mineral oxides, alkali and fade resistant. The dosage must not exceed 10 percent by weight of cementitious material in the concrete mix design.
 - a. Lampblack: Conform to ASTM D209, and shall be of approved quality mixed at a rate of one pound per cubic yard of concrete.
 - b. Color: No added color unless specified otherwise on the Drawings, except lampblack.

2.3 CONCRETE MIX

A. Concrete Mix:

1. Concrete shall conform to Section 90, "Concrete", of the State Standard Specifications.
2. The concrete shall contain not less than 564 pounds of cementitious material per cubic yard.
3. Maximum slump for concrete is 4".
4. Provide concrete to the following criteria:

Item	Min. 28-day Compressive Strength (psi)
Sidewalks	4,000
Driveways	4,000
Curb Ramps	4,000
Curb and Gutters	4,000
Median Curbs	4,000
Median Nose Surfacing	4,000
Concrete Ditches	4,000
Valley Gutters	5,000
Bus Turnouts	5,000
Survey Monuments	5,000

2.4 CONCRETE CURING COMPOUND

- A. Curing Compound: ASTM C309, Type 1D, Class A and shall conform to Section 90-1.03B (3) “Curing Compound Method”, of the State Standard Specifications.

2.5 SOURCE QUALITY CONTROL

- A. [Section 01 45 00 - Quality Control](#): Testing and Inspection Services.
- B. Submit proposed mix design of each class of concrete to City for review prior to commencement of Work.
- C. Concrete Slump shall conform to Section 90-1.02G (6) “Quantity of Water and Penetration or Slump”, of the State Standard Specifications
- D. Tests on cement, aggregates, and mixes will be performed to ensure conformance with specified requirements.

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. [Section 01 70 00 - Execution](#) and [Section 01 77 00 - Closeout Requirements](#): Requirements for installation examination.
- B. Verify compacted subgrade and base is dry and ready to support paving and imposed loads.
 - 1. Proof roll subgrade with two perpendicular passes to identify soft spots.
 - 2. Remove soft subgrade and replace with compacted fill as specified in [Section 31 05 13 – Clearing & Grubbing, Excavation, and Earthwork](#).
- C. Verify gradients and elevations of base are correct.

3.2 PREPARATION

- A. [Section 01 70 00 - Execution](#) and [Section 01 77 00 - Closeout Requirements](#): Requirements for installation preparation.
- B. Moisten subgrade to minimize absorption of water from fresh concrete.
- C. Notify City minimum 24 hours prior to commencement of concrete operations.

3.3 INSTALLATION

- A. Subgrade Preparation:
 - 1. Remove soft or spongy basement material to a depth of six (6) inches below the subgrade elevations for sidewalks, driveways, curb ramps, curbs, gutter depressions, median nose island paving, valley gutters, bus turnouts, and other miscellaneous concrete pads. Backfill the subgrade with earth, sand, gravel or suitable backfill materials to produce a stable foundation.
 - 2. The subgrade, including any base material, shall be thoroughly compacted by an approved mechanical device to not less than ninety-five percent (95%) relative compaction as determined by Test Method No. Calif. 216 or 231 before placing the concrete at bus turnouts, driveways and valley gutters.
 - 3. The subgrade, including any base material, shall be thoroughly compacted by an approved mechanical device to not less than ninety percent (90%) relative compaction as determined by Test Method No. Calif. 216 or 231 before placing the concrete at curb and gutters, sidewalk, median nose surfacing and curb ramps.

- B. Sawcutting Existing Concrete:
1. Where a portion of existing concrete surface improvements is to be removed and replaced, the section to be removed shall be sawcut with an approved concrete saw to a minimum depth of 2-1/2 inches. For sidewalks, curbs, gutters, concrete pads, curb ramps, and driveways the limit of the saw cut shall be at a minimum the first score line beyond the limits of the area to be replaced or as directed by the City.
- C. Base Course:
1. Aggregate Base Course: Install as specified in [Section 32 11 23 - Aggregate Base Courses](#).
- D. Forms:
1. No forms shall be placed prior to approval of the aggregate base and subgrade by the City.
 2. Place and secure forms and screeds to correct location, dimension, profile, and gradient.
 3. All dirt, chips, soil, dust, nails, and other foreign matter shall be completely removed from forms before any concrete is deposited therein.
 4. Form boards having joints opened by shrinkage of the wood shall be swelled by wetting until closed, before concrete is placed.
 5. The design and construction of forms and form supports shall be subject to approval, but responsibility for their adequacy shall rest with the Contractor.
 6. Forms shall be carefully set to alignment and grade and shall conform to the required dimensions. Forms shall be held rigidly in place by stakes. Clamps, spreaders and braces shall be used where required to insure rigidity in the forms.
 7. Assemble formwork to permit easy stripping and dismantling without damaging concrete.
 8. When grades are less than 0.4 percent, the Contractor shall set grade stakes at a minimum of 25 foot intervals.
 9. Where shown on the Drawings, specified in the Technical Specifications or permitted by the City, side forms for footings may be omitted and concrete may be poured against the firm earth.
- E. Coating:
1. Before concrete is placed, the contact surfaces for forms shall be coated with an approved non-staining form coating compound.
 2. Forms previously used shall be thoroughly cleaned of all dirt, mortar, and foreign matter before being re-used.
 3. When forms are coated to prevent bond with concrete, coating shall be done prior to placing of the reinforcing steel.
 4. Excess coating material shall not be allowed to stand in puddles in the forms nor allowed to come in contact with concrete against which fresh concrete will be placed
- F. Reinforcement:

1. Place reinforcing as indicated on Drawings.
2. Interrupt reinforcing at weakened plane and expansion joints as shown on the Drawings.
3. Place dowels where required to achieve concrete paving and curb alignment as detailed.

G. Ties:

1. Approved form clamps or bolts shall be used to fasten forms.
2. The use of ties consisting of twisted wire loops to hold forms in position during the placing of concrete will not be permitted.
3. Bolts and form clamps shall be positive in action and shall be of sufficient strength and number to prevent spreading of the forms.
4. They shall be of such type that when the forms are removed all metal shall be at least one (1) inch from any surface.
5. Spreader cones and ties shall not exceed one (1) inch in diameter. These shall be of the type which do not have to be completely withdrawn as holes through the wall will not be permitted

H. Joints

1. Place weakened plane joints at D/4 (1" deep and 1/8" wide with rounded edges of 1/8" radius for a 4" thick concrete sidewalk) at maximum of 10 foot intervals, unless shown otherwise on the Drawings. Align curb, gutter, and sidewalk joints.
2. Place expansion joints (full depth of concrete section and 1/2" wide) at maximum of 40 foot intervals, at begin and end of curve, all changes in horizontal alignment, back of sidewalk at driveways, at corners of tree wells and corners of utility vaults, unless shown otherwise on the Drawings. Align curb, gutter, and sidewalk joints.
3. Place joint filler between concrete paving components and building or other appurtenances. Recess top of filler 1/4 inch for sealant installation.
4. Seal all expansion joints as shown on the Drawings.
5. The joint opening shall be thoroughly cleaned before the sealing material is placed.
6. Sealing material shall not be spilled on exposed surfaces of the concrete. Any excess material on exposed surfaces of the concrete shall be removed immediately and concrete surfaces cleaned.
7. Provide scored joints transversely (1/4" deep and 1/8" wide with rounded edges of 1/8" radius for a 4" thick concrete sidewalk) at maximum of 5 foot intervals, unless shown otherwise on the Drawings and between sidewalk and back of curbs at an optimum time after finishing. Provide additional score lines longitudinally at mid-point on sidewalks 8 feet and over in width.
8. Provide keyed joints as indicated.
9. For sidewalk replacement projects, match adjacent scoring and joint pattern.

I. Inspections prior to Placing Concrete:

1. All excavations, false-work, forms, reinforcement, joints made prior to pouring, electrical and mechanical inserts, etc., shall be inspected and approved before concrete is placed, and if found unsatisfactory the work shall not proceed until all defects have been remedied. Approval will in no way relieve the Contractor of his obligations to produce the finished concrete required by the Drawings and the Specifications

J. Placing Concrete:

1. Place concrete according to Section 73, "Concrete Curbs and Sidewalks" of the State Standard Specifications.
2. All concrete shall be placed while fresh and before it has taken an initial set.
3. Re-tempering partially hardened concrete with additional water or vibrating will not be permitted.
4. Runways or other means must be provided to convey the concrete to the place of deposit in order not to disturb forms or reinforcement. Runways shall not be blocked up on reinforcement and wheel barrows shall not be run directly over reinforcement.
5. Immediately before placing reinforcement or pouring concrete on the ground, the surface of the ground shall be brought to a true, even plane, and compacted to a solid bearing by rolling or tamping. The subgrade surface shall then be dampened to prevent absorption of water from the concrete. Too much water shall not be used and no pools shall form on the area to receive concrete.
6. Concrete shall be effectively protected from freezing or frost for period of 5 days after placing.
7. The concrete shall be deposited as nearly as possible in its final position and the use of vibrators for extensive shifting of the mass of fresh concrete will not be permitted.
8. Fresh concrete shall not be permitted to fall from a height greater than 4 feet without the use of adjustable pipes or "elephant trunks."
9. Concrete shall be placed with square ends and level tops. Concrete shall be deposited continuously or in layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section.
10. The Contractor shall stamp an appropriate two (2) inch symbol S, W or C in the top of curb at all locations where sanitary sewer, water or conduit crosses under curbs.
11. All exposed edges shall be tooled with a one-half inch (1/2") radius tool.
12. If a section cannot be placed continuously, keyed construction joints shall be located at points as indicated or as approved. Placing shall be carried out at such a rate that the concrete which is being integrated with fresh concrete is still plastic.
13. Concrete placement shall be stopped at construction joints before rainfall starts or is sufficient to cause damage to the work.
14. Poured work shall be covered and protected.
15. Concrete, after being deposited, shall be consolidated until all voids are filled and free mortar appears on the surface.

16. Consolidate the concrete by means of high frequency internal vibrators of type, size, and number as approved by the City. The number of vibrators employed shall be ample to consolidate the incoming concrete to a proper degree within 15 minutes after it is deposited in forms. Vibrators shall not be attached to nor held against the forms or the reinforcing steel. The location, manner, and duration of the application of the vibrators shall be such as to secure maximum consolidation of the concrete without causing segregation of mortar and coarse aggregate and without causing water or cement paste to flush to the surface. The thickness of the layers shall be not greater than can be satisfactorily consolidated with the vibrators. The vibrators shall vertically penetrate a few inches into the previous lift (which should not be rigid) at regular intervals. The use of approved external vibrators for consolidating concrete will be permitted when the concrete is inaccessible for adequate consolidation, provided the forms are constructed sufficiently rigid to resist displacements and damage from external vibration.
17. The forms on the face of curbs shall not be removed while the concrete is sufficiently plastic to slump.

K. Finishing:

1. After the concrete has been placed and consolidated, the surface of the concrete shall receive a preliminary finish. The preliminary finish shall consist of carefully striking of the surface of the concrete with a template, strike board, or approved compacting type screed, operated on and between supports or headers, until a uniform surface is obtained.
2. Horizontal surfaces shall receive a broom finish unless otherwise shown on the Drawings. Make the broom finish perpendicular to the path of travel on surfaces used by Pedestrians.
3. Miscellaneous concrete footings shall be sloped to provide drainage away from the post/pipe.
4. Imperfect or Damaged Work: The Contractor shall repair and clean all concrete damaged or discolored during construction.
5. Finishing Unformed Surfaces: Following completion of the preliminary finish, a final finish of the type indicated shall be provided.

L. Curing and Protection

1. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
2. Curing concrete shall conform to Section 90-1.03B – “Curing Concrete”, of the State Standard Specifications.
3. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
4. Membrane-Curing Compound: Apply curing compound in two coats with second coat applied at right angles to first over the entire exposed faces of the concrete.
5. Do not permit traffic over unprotected surfaces.

3.4 TOLERANCES

- A. [Section 01 45 00 – Quality Control](#): Tolerances.
- B. Maximum Variation from True Position: 1/4 inch.
- C. The finished surface must not vary more than 0.02 foot from a 10-foot straightedge except at grade changes.

3.5 FIELD QUALITY CONTROL

- A. [Section 01 77 00 - Closeout Requirements](#): Requirements for testing, adjusting, and balancing.
- B. Perform field inspection and testing according to State Standard Specifications.
- C. Inspect reinforcing placement for size, spacing, location, support.
- D. For development projects, Developer's or Contractor's testing firm will take cylinders and perform slump and air entrainment tests according to ACI 301. For City projects, the City's testing team will perform testing.
- E. Clean any discolored concrete by abrasive blast cleaning or other authorized method.
- F. Strength Test Samples:
 - 1. Sampling Procedures: ASTM C172.
 - 2. Cylinder Molding and Curing Procedures: ASTM C31, cylinder specimens, standard cure/field cured.
 - 3. The frequency of sampling will be determined by the City.
 - 4. Sample concrete and make at a minimum of one set of three cylinders (each cylinder must be six (6) inches in diameter by 12 inches depth) for every 100 cubic yards less of each class of concrete placed each day and for every 5,000 square feet of surface area paving.
 - 5. Make one additional cylinder during cold weather concrete and placement, and field cure.
- G. Field Testing:
 - 1. Slump Test Method: ASTM C143.
 - 2. Air Content Test Method: ASTM C173 or ASTM C231.
 - 3. Temperature Test Method: ASTM C1064.
 - 4. Density: ASTM C138
 - 5. Measure slump and temperature for each compressive strength concrete sample.
 - 6. Measure air content in air entrained concrete for each compressive strength concrete sample.

- H. Cylinder Compressive Strength Testing:
 - 1. Test Method: ASTM C39.
 - 2. Test Acceptance: Average compressive strength of three consecutive compressive strength test shall be equal to or greater than minimum specified compressive strength specified in this Section. No single strength test should fall below the specified compressive strength by more than 500 psi.
 - 3. Test one cylinder at 7 days.
 - 4. Test two cylinders at 28 days.
 - 5. Retain one cylinder for testing when requested by City.
 - 6. Dispose remaining cylinders when testing is not required.
- I. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.
- J. The finished surface shall be true and straight, and shall be of uniform width, free from humps, sags, or other irregularities.
- K. Where curb and gutter, valley gutter and bus turnout gutter grades are less than one percent (1%), the Contractor shall water test the gutters for low spots. Any depressions shall be corrected prior to asphalt concrete paving.

3.6 PROTECTION

- A. [Section 01 77 00 - Closeout Requirements](#): Requirements for protecting finished Work.
- B. Immediately after placement, protect paving from premature drying, excessive hot or cold temperatures, and mechanical injury.
- C. Do not permit pedestrian or vehicular traffic over paving for 7 days minimum after finishing until 75 percent design strength of concrete has been achieved, unless approved by the City.
- D. Vandalism: Contractor shall be responsible for protection of newly poured concrete against vandalism. Any damage to the newly poured concrete shall be the responsibility of the Contractor and shall be replaced at the Contractor's expense.

END OF SECTION 32 13 13

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SECTION 32 17 00 - PAVEMENT DELINEATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Work under this section shall consist of all traffic striping, markings and all other directional information or pavement delineation on the surfaces of streets, detour roads, parking lots, median strips and curbing in accordance with the plans, Technical Specifications and as specified herein, in conformance with the applicable provisions of the Department of Transportation Standard Specifications, California Manual on Uniform Traffic Control Devices (CA MUTCD), and California Vehicle Code.
- B. Related Sections:
 - 1. [Section 01 33 00 – Submittal Procedures](#)
 - 2. [Section 01 60 00 - Product Requirements](#)
 - 3. [Section 01 77 00 - Closeout Requirements](#)
 - 4. [Section 01 78 00 - Closeout Submittals](#)

1.2 REFERENCES

- A. Department of Transportation (Caltrans Standard Specifications)
- B. California Manual on Uniform Traffic Control Devices (CA MUTCD)
- C. California Vehicle Code (CVC)

1.3 SUBMITTALS

- A. [Section 01 33 00 - Submittal Procedures](#): Submittal procedures.
- B. Certificates of Compliance: Certificates of Compliance shall be provided for all products and materials proposed to be used under this Section.
- C. Product Data: Provide manufacturers specification and literature for materials furnished.

1.4 CLOSEOUT SUBMITTALS

- A. [Section 01 78 00 - Closeout Submittals](#): Requirements for submittals.

1.5 QUALITY ASSURANCE

- A. Perform work in accordance with the plans, Technical Specifications and as specified herein, in conformance with the applicable provisions of the Caltrans Standard Specifications, CA MUTCD, and CVC.

1.6 QUALIFICATIONS

- A. Pavement markings installer shall have experience in the type of work required and a reputation for producing satisfactory work on time.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. [Section 01 60 00 - Product Requirements](#): Product transportation, storage, handling, and protection requirements.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.
- D. Do not deliver items to project before time of installation. Limit shipment of bulk and multiple-use materials to quantities needed for immediate installation.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. [Section 01 60 00 - Product Requirements](#): Environmental conditions affecting products on site.
- B. Install pavement markers only when ambient temperature and humidity conditions acceptable per manufacturer's specifications.
- C. Testing and removal of yellow traffic stripe and pavement markings with hazardous waste residue shall be in conformance with Department of Transportation Standard Specification 14-11.12, "Removal of Yellow Traffic Stripe and Pavement Marking with Hazardous Waste Residue".

1.9 MAINTENANCE/EXTRA MATERIALS

- A. [Section 01 77 00 - Closeout Requirements](#): Extra materials and maintenance products.

PART 2 - PRODUCTS**2.1 GENERAL**

- A. Unless otherwise specified in the Technical Specifications or contract plans, all pavement striping and markings (except temporary) shall be thermoplastic.

2.2 THERMOPLASTIC

- A. Thermoplastic for traffic stripes and pavement markings shall conform to Section 84-2, "Traffic Stripes and Pavement Markings", of the Caltrans Standard Specifications.
- B. The thermoplastic material shall conform to Caltrans Specification PTH-02SPRAY, PTH-02HYDRO or PTH-02ALKYD. Glass beads to be applied to the surface of the molten thermoplastic material shall conform to the requirements of Caltrans Standard Specification.
- C. Concrete surfaces shall be treated before thermoplastic stripes and markings are installed, per Section 84-2, "Traffic Stripes and Pavement Markings", of the Caltrans Standard Specification.

2.3 PAINT

- A. Paint for traffic stripes and pavements markings shall conform to Section 84-2, "Traffic Stripes and Pavement Markings", of the Caltrans Standard Specifications and the following:
 - 1. Waterborne Traffic Line (White, Yellow, Black): Caltrans Standard Specification PTWB-01
 - 2. Acetone-Based (White, Yellow, Black): Specification PT-150VOC(A)
 - 3. Waterborne Traffic Line for disabled persons' parking, and other curb markings (blue, red, green): Federal Specification No. TT-P-1952D
- B. Glass beads shall conform to Caltrans Standard Specification.

2.4 PAVEMENT MARKERS

- A. Pavement markers shall conform to Section 81-3, "Pavement Markers," of the Caltrans Standard Specifications, as specified herein, and in the Technical Specifications.
- B. Fire Hydrant markers shall be two-way, reflective blue markers.

2.5 TEMPORARY PAVEMENT DELINEATION

- A. Temporary Pavement Delineation shall conform to Section 12-6, "Temporary Pavement Delineation," and Section 84-2, "Traffic Stripes and Pavement Markings", of the Caltrans Standard Specifications.

2.6 ADHESIVE

- A. Adhesive for Pavement Markers shall be the hot melt bituminous type conforming to Section 81-3, "Pavement Markers," of the Caltrans Standard Specifications.

PART 3 - EXECUTION

3.1 LAYOUT, ALIGNMENT, AND SPOTTINGS

- A. All layout, spotting and tracking required shall be performed by and at the expense of the Contractor and approved by the City, prior to placement of pavement striping or markings.
- B. When no previously applied figures, markings, or traffic striping are available to serve as a guide, suitable layouts shall be spotted in advance of the permanent paint application by any means satisfactory to the City.
- C. The Contractor shall mark or otherwise delineate the traffic lanes in the new roadway or portion of roadway, or detour before opening it to traffic.
- D. The Contractor shall provide an experienced technician to supervise the location, alignment, layout, dimensions, and application of the delineation or marking.
- E. The Contractor shall furnish all equipment, materials, labor and supervision necessary for installing pavement striping and markings in accordance with the contract plans for temporary detours required for the safe control of traffic through and/or around the project.
- F. Standard word markings, letters, numerals, and symbols shall be as shown, on the plans. In the absence of such information, all stencils and templates shall be identical with those used by the City. The Contractor shall obtain stencils for all required legends.

3.2 TEMPORARY PAVEMENT MARKINGS

- A. Should the Contractor elect to alter the existing traffic stripes and markings, or to divert the flow of traffic on construction projects for his own convenience and

there are no special pavement markings or lane delineations shown on the plans or in the Technical Specifications, he shall, at no expense to the City, provide the necessary temporary striping in accordance with the CA MUTCD, unless otherwise directed by the City. Removal of such striping shall be at the Contractor's expense. The Contractor shall remove all existing or temporary detour striping or markings that may confuse the public. When temporary detour striping or markings are no longer required, they shall be removed prior to applying the new traffic stripes or markings.

- B. Temporary Traffic Stripe or Marking Tape shall be removed "clean" prior to installation of permanent pavement delineation.

3.3 REMOVAL OF EXISTING MARKINGS

- A. Existing striping and pavement markings that will be in conflict with the finish traffic circulation shall be removed as directed by the City in accordance with Section 84-9 of the Caltrans Standard Specifications.
- B. The Contractor shall conduct his work so as not to damage existing pavement and public improvements to remain. Any resultant damage determined to be excessive by the City shall be repaired in kind by the Contractor at its sole expense.
- C. Damage to the pavement resulting from removal of pavement markers shall be considered as any depression more than 1/4-inch (6.35mm) deep and shall be repaired by the Contractor by filling the depression with hot melt bituminous adhesive to the satisfaction of the City.
- D. Where blast cleaning is used for the removal of traffic stripes and pavement markings or objectionable material, the residue including dust shall be removed immediately after contact between the sand and the surface being treated. Such removal shall be by a vacuum attachment operating concurrently with the blast cleaning operation.
- E. Where removal of traffic stripes and pavement markings is done by grinding or sandblasting methods, the effected pavement surface shall be completely covered by applying asphaltic emulsion conforming to Section 94 of Caltrans Standard Specifications.
- F. All reference markings made by the Contractor shall be done with spray chalk.
- G. All temporary traffic stripes and pavement markings shall be removed by the Contractor on the same day as placement of the permanent striping and markings.

3.4 PAVEMENT MARKER INSTALLATION

- A. Placement of pavement markers shall conform to Section 81-3, "Pavement Markers," of the Caltrans Standard Specifications, as specified herein, and in the Technical Specifications.
- B. Fire hydrant markers shall be two-way blue retroreflective pavement markers and installed at all fire hydrant locations, as directed by the City.

3.5 PAVEMENT MARKINGS INSTALLATION

- A. Placement of all traffic stripes and pavement markings shall be in conformance with Section 84, "Markings" of the Caltrans Standard Specifications, referenced Plans of the Caltrans Standard Plans, with color required as shown on the Drawings and as specified herein.
- B. Any overlap, dripping, or tracking of fresh thermoplastic or paint onto unmarked surfacing shall be removed to the satisfaction of the City.
- C. Thermoplastic and paint shall be placed as close as possible to existing utility structure and monument frames and covers without covering them.
- D. The Contractor shall protect all fresh thermoplastic and paint and shall repair or replace all damage to traffic stripes and pavement markings caused by his failure to do so at its own expense.
- E. All traffic stripes and pavement markings, new or existing, within or adjacent to the work limits which become defaced or damaged during the Contractor's operations shall be replaced by the Contractor at its expense concurrently with other traffic marking operations in the immediate area. The City shall be the sole judge as to which stripes or legends are defaced or damaged.
- F. Curb painting shall be applied as shown on the plans and as directed by the City. Curb painting shall include the application of two coats of traffic paint with glass beads incorporated in the second coat. Top and face of curb shall be painted. Color of curb markings shall conform to ASTM D6628.
- G. All traffic stripes and pavement markings shall be placed at application rates in conformance with Section 84-2, "Traffic Stripes and Pavement Markings", of the Caltrans Standard Specifications.

3.6 GLASS BEAD APPLICATION

- A. All traffic stripes, except the black separation line, shall be beaded.

- B. Glass beads shall be applied directly and uniformly to the set traffic line with a bead dispenser machine placed the proper distance behind the paint spray nozzle, unless pre-mix is approved.
- C. Glass beads shall be applied to pavement markings and crosswalks by a special paint spray gun developed for this purpose.
- D. Glass beads shall be applied at application rates in conformance with Section 84-2, "Traffic Stripes and Pavement Markings", of the Caltrans Standard Specifications.:

3.7 CLEANING

- A. [Section 01 77 00 - Closeout Requirements](#): Final cleaning.
- B. Clean finishes and touch up damage.

3.8 PROTECTION OF FINISHED WORK

- A. [Section 01 77 00 - Closeout Requirements](#): Protecting finished work.

END OF SECTION 32 17 00

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SECTION 32 17 26 - DETECTABLE WARNING SURFACING**PART 1 - GENERAL**

1.1 SUMMARY

- A. Section Includes: Detectable warning surfacing and accessories at curb ramps, median opening islands, and at other locations as shown on the drawings.
- B. Related Requirements:
 - 1. [Section 01 50 00 - Temporary Facilities and Controls](#): Short-term traffic control as required by this Section.
 - 2. [Section 32 12 16 - Asphalt Paving](#): Coordination with paving systems for equipment specified in this Section.
 - 3. [Section 32 13 13 - Concrete Surface Improvements](#): Coordination with paving systems for equipment specified in this Section.

1.2 UNIT PRICE - MEASUREMENT AND PAYMENT

- A. [Section 01 29 00 - Payment Procedures](#): Contract Sum/Price modification procedures.
- B. Detectable Warning Surfacing:
 - 1. Basis of Measurement: Detectable domes shall be included in the cost of curb ramps and median island openings unless specified otherwise in the Technical Specifications.
 - 2. Basis of Payment: Includes furnishing, installing, inspecting, and maintaining detectable warning surfacing until final inspections.

1.3 REFERENCE STANDARDS

- A. American Association of State and Highway Transportation Officials:
 - 1. AASHTO HB-17 - Standard Specifications for Highway Bridges.
- B. ASTM International:
 - 1. ASTM C1371 - Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers.
 - 2. ASTM C1549 - Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer.
 - 3. ASTM D570 - Standard Test Method for Water Absorption of Plastics.

4. ASTM D638 - Standard Test Method for Tensile Properties of Plastics.
 5. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 6. ASTM D1044 - Standard Test Method for Resistance of Transparent Plastics to Surface Abrasion.
 7. ASTM D2240 - Standard Test Method for Rubber Property - Durometer Hardness.
 8. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 9. ASTM E303 - Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester.
 10. ASTM E408 - Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.
 11. ASTM E903 - Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres.
 12. ASTM E1918 - Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field.
 13. ASTM E1980 - Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces.
- C. U.S. Architectural and Transportation Barriers Compliance Board (Access Board):
1. Americans with Disabilities Act (ADA) - Accessibility Guidelines for Buildings and Facilities.
- D. California Code of Regulations (CCR): Provide only approved DSAAC detectable warning products as provided in the California Code of Regulations (CCR) Title 24, Chapter 2, Section 202 definition of "Detectable Warning". Section 11B-247 and 11B-705 "Detectable Warnings And Detectable Directional Texture"
- E. Caltrans Standard Specifications
1. Section 73 – Concrete Curbs and Sidewalks.
- F. California Building Code (CBC).
- 1.4 COORDINATION
- A. Coordinate Work of this Section with Work of other Sections.
- 1.5 SUBMITTALS
- A. [Section 01 33 00 - Submittal Procedures](#) specifies requirements for submittals.

- B. Product Data: Submit manufacturer's information including characteristics, dimensions, domes, and special shapes.
- C. Manufacturer's Certificate: Certify that product meets or exceeds specified requirements.
- D. Manufacturer's Instructions: Submit detailed instructions on installation requirements, including storage, cleaning and handling procedures.
- E. Submit maintenance recommendations.
- F. Source Quality-Control Submittals: Indicate results of factory tests and inspections.
- G. Manufacturer Reports:
 - 1. Certify that equipment has been installed according to manufacturer's instructions.
 - 2. Indicate activities on Site, adverse findings, and recommendations.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. [Section 01 60 00 - Product Requirements](#): Requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Store and protect materials according to manufacturer's instructions. Finished surfaces shall be protected by sturdy wrappings.

1.7 WARRANTY

- A. [Section 01 78 00 - Closeout Submittals](#): Requirements for warranties.
- B. Furnish five (5) year manufacturer's warranty for detectable warning surfacing.

PART 2 - PRODUCTS

2.1 DETECTABLE WARNING SURFACING

- A. Manufacturer List:
 - 1. Armor-Tile Tactile Systems by Engineered Plastics, Inc.
 - 2. ADA Solutions

3. Or approved equal

B. Description:

1. ADA-compliant detectable warning surfaces for visually impaired pedestrians.
2. Suitable for installation on both asphalt and concrete.

C. Design and Performance Criteria:

1. Loading: Single-wheel HS20-44, according to AASHTO HB-17.
2. Resistant to impacts, wear, freeze-thaw, UV exposure, and stains.
3. Fire Spread: Less than 25 when tested according to ASTM E84.
4. Slip Resistance: 0.80, according to ASTM E303.
5. Taber Abrasion: 150 mgs, according to ASTM D1044.
6. Durometer Hardness: 90, according to ASTM D2240, Type A.
7. Water Absorption:
 - a. Comply with ASTM D570.
 - b. Maximum: 0.05 percent.
8. Minimum Strengths:
 - a. Compressive: 28,000 psi according to ASTM D695.
 - b. Flexural: 25,000 psi, according to ASTM D790.
 - c. Tensile: 11,000 psi, according to ASTM D638.
9. Slip Resistance:
 - a. Static coefficient of friction (Dry): 1.03.
 - b. Static coefficient of friction (Wet): 0.83.
 - c. Wheelchair Safety: Furnish minimum 40, 90-degree raised 0.045-inch points per sq. in.
 - d. Spacing: Center to center spacing of 2.30-inches minimum to 2.40-inches maximum, and base-to-base spacing of 0.65-inches minimum, measured between the most adjacent domes on a square grid.

Exception: Where installed in a radial pattern, truncated domes shall have a center-to-center spacing of 1.60-inches minimum to 2.40-inches maximum.
 - e. Size: Base bottom diameter of 0.90-inches minimum and 0.92-inches maximum, top diameter of 0.45-inches minimum and 0.47-inches maximum, and a height of 0.2-inches.

D. Cast-in-Place-Type:

1. Epoxy polymer, glass-reinforced, thermoset composite
2. Length and Width: As shown on the Drawings.
3. Depth: 1-3/8 inches.
4. Face Thickness: 3/16 inch
5. Color: Yellow, FS33538 of Federal Standard 595C. Color shall be homogeneous throughout the detectable warning surface.
6. Detectable Warning surfaces shall provide a 70 percent minimum visual contrast with adjacent walking surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. [Section 01 70 00 - Execution](#): Requirements for installation examination.
- B. Verify that substrate is level or to correct grade, is smooth, is capable of supporting detectable warning surface units and imposed loads, and is otherwise ready to receive Work of this Section.

3.2 PREPARATION

- A. Maintenance and Protection of Traffic:
 1. Provide short-term traffic control as specified in [Section 01 50 00 - Temporary Facilities and Controls](#).
 2. Prevent interference with operations.
 3. Maintain access to existing business and other properties requiring access.
- B. Surface Preparation:
 1. Clean and dry paved surface prior to installing detectable warning surface modules.
 2. Blow or sweep surface free of dirt, debris, oil, grease, or gasoline.
 3. Cleaning materials used on site shall have code acceptable low VOC solvent content and low flammability.
- C. Existing Work:
 1. Remove existing detectable warning surface modules by methods that will cause least damage to pavement surface.
 2. Repair pavement or surface damage caused by removal operations.

3.3 INSTALLATION

- A. Install detectable warning surfacing according to manufacturer's instructions. Contractor shall use whole pieces before using any cut pieces of domes.
- B. The concrete shall be poured and finished, true and smooth to the required dimensions and slope prior to Cast-in-Place Detectable Warning Surfacing.
- C. Cast-in-Place Detectable Warning Surfacing shall be tamped or vibrated into the fresh concrete to ensure that there are no voids or air pockets, and the field level of the Cast-in-Place Detectable Warning Surfacing is flush to the adjacent concrete surface or as the Drawings indicate to permit proper water drainage and eliminate tripping hazards between adjacent finishes.

3.4 FIELD QUALITY CONTROL

- A. [Section 01 77 00 - Closeout Requirements](#): Requirements for testing, adjusting, and balancing.
- B. Inspect for correct location, extent of coverage, and final grade.

3.5 CLEANING

- A. Clean detectable warning surfacing according to manufacturer's instructions.

3.6 PROTECTION

- A. During and after the detectable warning surfacing installation and the concrete curing stage, it is imperative that there are no walking, leaning or external forces placed on the detectable warning surfacing to rock the detectable warning surfacing, causing a void between the underside of the detectable warning surfacing and the concrete.
- B. Protect detectable warning surfacing from vehicular and pedestrian traffic on newly installed detectable warning surface modules for period of time as instructed by manufacturer.
- C. Remove Protective Plastic Sheeting from detectable warning surfacing within 24 hours of installation of the detectable warning surfacing. Particularly under hot weather conditions (80 degrees or higher), plastic sheeting will adhere strongly (resulting in difficult removal of same) to detectable warning surfacing when not removed quickly.
- D. While detectable dome installation is susceptible to vandalism, Contractor shall have someone present on-site to ensure that the detectable dome installation isn't damaged.

END OF SECTION 32 17 26

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SECTION 32 31 13 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fence framework, fabric, and accessories.
2. Excavation for post bases.
3. Concrete foundation for posts and center drop for gates.
4. Manual gates and related hardware.
5. Privacy slats.

B. Related Sections:

1. [Section 03 30 00 – Utility Cast-in-place concrete](#)

1.2 UNIT PRICE - MEASUREMENT AND PAYMENT

A. Fencing:

1. Basis of Measurement: By linear foot measured along the base of the fence to the fence height specified, based on specified post spacing.
2. Basis of Payment: Includes posts, rails, tension wire, fabric, accessories, attachments.

B. Post Footings:

1. Basis of Measurement: Not Measured.
2. Basis of Payment: Includes excavation, concrete placed, finishing and is incidental to the price paid per linear foot for Chain link fence or unit price paid for Gates as shown on the bid form.

C. Gates:

1. Basis of Measurement: Measured as each to the gate width and height specified.
2. Basis of Payment: Includes excavation, concrete post & gate footings, finishing, frame posts, fabric, accessories, hardware.

1.3 REFERENCES

A. ASTM International:

1. ASTM A121 - Standard Specification for Metallic-Coated Carbon Steel Barbed Wire.
 2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 3. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 4. ASTM A392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
 5. ASTM A491 - Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric.
 6. ASTM A817 - Standard Specification for Metallic-Coated Steel Wire for Chain-Link Fence Fabric and Marcellled Tension Wire.
 7. A1011/A1011M-07 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
 8. ASTM B42 - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
 9. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
 10. ASTM F552 - Standard Terminology relating to Chain Link Fencing.
 11. ASTM F567 - Standard Practice for Installation of Chain-Link Fence.
 12. ASTM F626 - Standard Specification for Fence Fittings.
 13. ASTM F668 - Standard Specification for Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric.
 14. ASTM F900 - Standard Specification for Industrial and Commercial Swing Gates.
 15. ASTM F934 - Standard Specification for Standard Colors for Polymer-Coated Chain Link Fence Materials.
 16. ASTM F1043 - Standard Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.
 17. ASTM F1083 - Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
 18. ASTM F1183 - Standard Specification for Aluminum Alloy Chain Link Fence Fabric.
 19. ASTM F1184 - Standard Specification for Industrial and Commercial Horizontal Slide Gates.
 20. ASTM F1345 - Standard Specification for Zinc - 5% Aluminum -Mischmetal Alloy-Coated Steel Chain-Link Fence Fabric.
- B. Chain Link Fence Manufacturers Institute:
1. CLFMI - Product Manual.
- C. State Standard Specifications
1. Section 75 Miscellaneous Metal
 2. Section 80 Fences

1.4 SYSTEM DESCRIPTION

- A. Fence Height: Six (6) feet nominal, unless otherwise indicated otherwise on the Drawings.
- B. Line Post Spacing: At intervals not exceeding ten (10) feet, unless otherwise indicated otherwise on the Drawings.
- C. Fence Post and Rail Strength: Conform to ASTM F1043 quality, unless otherwise indicated otherwise on the Drawings.

1.5 SUBMITTALS

- A. [Section 01 33 00 - Submittal Procedures](#): Requirements for submittals.
- B. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, gates, and schedule of components.
- C. Product Data: Submit data on fabric, posts, accessories, fittings and hardware.
- D. Manufacturer's Installation Instructions: Submit installation requirements and post foundation anchor bolt templates.
- E. Submit structural calculations and structural details for footings, posts and rail diameter for Chain Link Fences greater than six (6) feet in height and for gates longer than 16 feet with any gate leaf greater than 8 feet in length.
- F. For fence to be located on or near the property line, and prior to the Contractor installing fence, Contractor's licensed land surveyor to obtain the recorded property line map and stake the property line every 50 feet along the fence and at all changes in direction.
- G. Contractor to obtain from the Engineer the dimension from the line post and corner post to the property line.

1.6 CLOSEOUT SUBMITTALS

- A. [Section 01 78 00 - Closeout Submittals](#): Closeout procedures.
- B. Project Record Documents: Accurately record actual locations of property perimeter posts relative to property lines and easements.
- C. Operation and Maintenance Data: Procedures for submittals.

1.7 QUALITY ASSURANCE

- A. Supply material according to CLFMI - Product Manual.
- B. Perform installation according to ASTM F567.
- C. Perform Work according to 2018 Caltrans Standard Plans A85, 85A, and A85B.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three (3) years documented experience.

1.9 DELIVERY, STORAGE AND HANDLING

- A. [Section 01 60 00 - Product Requirements](#): Requirements for transporting, handling, storing, and protecting products.
- B. Deliver fence fabric and accessories in packed cartons or firmly tied rolls.
- C. Identify each package with manufacturer's name.
- D. Store fence fabric and accessories in secure and dry place.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers:
 - 1. Master Halco
 - 2. Pacific Fence and Wire Company
 - 3. Allied Tube & Conduit, a part of Atkore International.
 - 4. Amico Corporation
 - 5. Or approved equal.

2.2 MATERIALS AND COMPONENTS

- A. Materials and Components: Conform to CLFMI Product Manual.
- B. Fabric Size: Chain link fabric must comply with AASHTO M 181 for Type 1 fabric (zinc-coated steel) with a class C coating (1.2 oz/ft²) or ASTM F1345, Class 2 (1.0 oz/ft² - Zinc-5% Aluminum-Mischmetal Alloy Coated Steel Fabric). The wire for the fabric must be 11 gauge for a fence height 84 inches or less in height and 9 gauge for a fence over 85 inches in height and for a slatted chain link fence.

Chain link fabric for fence must have the diamond count corresponding to the fabric height as shown in the following table:

Fabric Height (inches)	36	42	48	60	72	84	96
Diamond Count	10- 1/2	12- 1/2	13-1/2	17-1/2	20- 1/2	24- 1/2	27- 1/2

- C. Chain link fabric for slatted fence must have 3-1/4-inch-vertical and 5-1/4-inch horizontal mesh. Knuckle finish fabric on the top and bottom edges.
- D. Posts and Braces: The base metal for posts and braces must be commercial-quality, weldable steel complying with AASHTO M181, Type 1, except for the protective coating requirements.
- E. Posts and braces must comply with the strength requirements in ASTM F1043:
1. Group IA (Round Steel Pipe-Schedule 40), regular grade, for round posts
 2. Group II-L (Roll formed Steel Shapes – C-Sections), for roll-formed posts and braces.
- F. Galvanize posts and braces as required per State Standard Specification section 75-1.02B, except, instead of galvanizing, tubular posts and braces may have a protective coating system complying with the following:
1. Exterior surfaces of tubular posts and braces must have a combination coating consisting of hot-dip galvanized primer followed by a chromate conversion coating, and then a finish coat of clear, cross-linked organic coating. For this combination coating:
 - a. Thickness of the zinc coating must be at least 0.9 mil as determined from the average results of at least 2 samples and at least 0.8 mil on an individual sample.
 - b. Chromate conversion coating must be at least 15µg/square inch.
 - c. Total thickness of the combination coating must be at least 1.7 mils.
 - d. Clear finish coat must not have any film cracking after 500 hours of exposure in an artificial weathering device under one of the following:
 - 1) ASTM G152, cycles 1, or 3 Carbon Arc artificial weathering device.
 - 2) ASTM G155, cycles 1, or 2 Xenon Arc artificial weathering device
 Clear finish coat must not have blistering or cracking after 500 hours of exposure to 100 percent relative humidity under ASTM D2247.
 2. Interior surfaces must have a zinc coating or a cross-linked organic coating containing a corrosion inhibitor. For these coating:
 - a. Coating thickness must be at least 0.3 mil.

- G. Each post must have provisions to securely hold the top tension wire in position and allow for post removal and replacement without damaging the wire. Fit each tubular post with rainproof top.
- H. Post tops, extension arms, stretcher bars, and other fittings and hardware must be:
 - 1. Steel or malleable or wrought iron
 - 2. Galvanized after fabrication per State Standard Specification Section 75-1.02B.
- I. Galvanize or coat ferrous materials. Do not use materials imperfectly galvanized or imperfectly coated or with serious abrasion.
- J. Concrete: Type specified in [Section 03 30 00 – Utility Cast-in-Place Concrete](#).

2.3 GATES

A. General:

- 1. Gate Types, Opening Widths and Directions of Operation: As indicated on Drawings.
- 2. Factory assemble gates.
- 3. Each walk gate must be minimum four (4) feet wide, unless shown otherwise on Drawings. Maximum gate width is 24 feet or 2-12-foot gate leafs, unless shown otherwise on Drawings.
- 4. Gates greater than 8 feet in length must have vertical stays such that no panel exceeds 8 feet in length.
- 5. A gate frame must be made with pipe at least 1-1/2 inch in diameter.
- 6. Interior vertical stays must be made with pipe at least one (1) inch in diameter. Pipe must comply with the Specifications for post and braces as specified in this Section.
- 7. Each gate frame panel must be cross trussed with adjustable truss rods at least 3/8 inch in diameter.
- 8. Fasten and reinforce each corner of a gate frame by welding per the gusset detail shown on the Caltrans Standard Plans.
- 9. Each pressed steel fitting must have a nominal thickness before galvanizing of at least 0.135 inch and fastened to develop the strength of the connected members.
- 10. Factory welds must be smooth and develop the strength of the connected member.
- 11. Galvanize fittings, latches, rods, nuts, bolts, and other gate hardware per State Standard Specification section 75-1.02B.
- 12. Fabric for gates in chain link fences must comply with the specification for the fabric for the fence in which the gate is installed.

13. Attach chain link fence fabric to the gate frame using stretcher bars and tie wires as specified for fence construction. Space tension connectors at 1-foot intervals.
14. For a chain link walk gate installed in an existing fence, the gate mounting hardware must not contain open-end slots for the fastening bolts.
15. Each gate must have a combination steel or malleable iron catch and locking attachment that does not rotate around the latch post.
16. Design gates for operation by one person.

B. Swing Gates:

1. Fabricate gates to permit 180-degree swing.
2. Gates Construction: ASTM F900 with welded corners. Use of corner fittings is not permitted.

2.4 PRIVACY SLATS

- A. Slats must be wood or plastic. Wood slats must be clear redwood or as shown on Drawings.
- B. Each wood slat must have a thickness of at least 1/4 inch, width about 2-5/8 inch and length enough to fill the vertical openings of the fabric.
- C. Plastic slats must be HDPE with UV inhibitors and have a flat tubular cross section with a minimum wall thickness of 0.03 inch, minimum depth of 0.325 inch, minimum width of 2.38 inch, and length equal to the fence height.
- D. Plastic slat material must comply with the requirements shown in the following table:

Plastic Slat Material Requirements

Quality characteristic	Test Method	Requirement
Melt Index	ASTM D1238	0.24
Density	ASTM D1505	0.951
Low temperature brittleness (°F)	ASTM D746	-76
Tensile strength (psi)	ASTM D638	3,700

2.5 ACCESSORIES

- A. Caps: Galvanized pressed steel sized to post diameter, set screw retainer.

- B. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; galvanized steel.
- C. Extension Arms: Galvanized pressed steel to accommodate strands of barbed wire, [sloped to 45 degrees].
- D. Gate Hardware: Fork latch with gravity drop or center gate stop and drop rod for double gates; two 180-degree gate hinges for each leaf and hardware for padlock keyed.

2.6 FINISHES

- A. Components and Fabric: Galvanized to ASTM A123 for components; ASTM A153 for hardware; ASTM A392 for fabric.
- B. Components and Fabric: Vinyl coating, dark green color according to ASTM F934 over galvanized coating as selected and as shown on Drawings.
- C. Hardware: Galvanized to ASTM A153
- D. Accessories: Same finish as fabric.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Contractor shall contact Underground Service Alert (USA) and utility locators at least three (3) days prior to installation to identify and mark utilities around the proposed chain link fence to avoid damaging any utilities. Any utilities damaged shall be replaced at the Contractor's expense.
- B. Install framework, fabric, accessories and gates according to ASTM F567.
- C. Excavate holes for posts to diameter and spacing indicated on Drawings without disturbing underlying materials.
- D. Prior to drilling posts, mark gate width locations in the field and obtain written approval from City for gate location.
- E. Center and align posts. Place concrete around posts, and vibrate or tamp for consolidation. Verify vertical and top alignment of posts and make necessary corrections.
- F. Set intermediate, terminal, and gate posts plumb, in concrete footings with top of footing one (1) inch above finish grade. Slope top of concrete forming crown for water runoff.

- G. Line Post Footing Depth Below Finish Grade: ASTM F567; varies from 2.5 feet to 4 feet depending on height of fence as shown on Caltrans Standard Plans A85.
- H. Corner, Gate and Terminal Post Footing Depth Below Finish Grade: ASTM F567; varies from 2.5 feet to 4 feet depending on height of fence as shown on Caltrans Standard Plans A85.
- I. Allow footings to cure minimum seven (7) days before installing fabric and other materials attached to posts.
- J. Brace each end, latch, and corner post to the nearest line post with either of the following:
 - 1. Diagonal brace used as a compression member.
 - 2. Horizontal brace used as a compression member and truss rods used as tension member
- K. Install brace rail one bay from end and gate posts.
- L. Brace each gate post to the nearest line post with a horizontal brace used as a compression member and truss rods used as tension members.
- M. Equip each steel truss rod with a turnbuckle or truss tightener.
- N. Brace line posts horizontally and truss in both directions at intervals of at most 300 feet.
- O. Fasten chain link fabric on the side of the posts designated by the Engineer. Stretch and securely fasten the fabric to the posts.
- P. Fasten the top and bottom edges of the fabric to the tension wires. Stretch the tension wires tight.
- Q. Install the bottom tension wire on a straight grade between posts by excavating high points of the ground. Do not fill in low points.
- R. Fasten the fabric to end, latch, corner, and gate posts with stretcher bars and stretcher bar bands at 1-foot intervals except the fabric may be fastened to end and corner posts by threading through loops formed on the posts.
- S. Fasten the fabric to line posts with tie wires or post clips and to tension wires with tie wires or hog rings. Space the fasteners at about 14 inches on line posts and about 18 inches on tension wires. Give wire ties at least 1 complete turn. Close each hog ring with the ends overlapping. Wrap tension wires around terminal posts. The top of the fabric to the top tension wire must be at most 2 inches.
- T. If supporting arms for barbed wire are shown, extend each arm upward from the top of the fence at an angle of about 45 degrees. Fit it with clips or other means for attaching 3 lines of barbed wire. Attach the top outside wire to the supporting

arm at a point about 12 inches above the top of the chain link fabric and 12 inches out from the fence line. Attach the other wires to the arm spaced evenly between the top of the fence and the top outside wire.

- U. Hang each gate with at least 2 steel or malleable iron hinges at least 3 inches in width such that the gate is securely clamped to the gate post and permits the gate to be swung back against the fence. The bottom hinge must have a socket to take the ball end of the gate frame.
- V. Construct a center rest with a catch and stops to hold gates open.
- W. For a walk gate constructed in an existing fence, remove a line post and install the gate such that the gate is centered on the hole of the removed post. When not working on the walk gate, close the opening made in the existing fence with existing fence fabric or 6-foot chain link fabric.
- X. Install top rail through line post tops and splice with 6-inch-long rail sleeves.
- Y. Place fabric on outside of posts and rails, unless shown otherwise on Drawings or otherwise directed by Project Manager.
- Z. Do not stretch fabric until concrete foundation has cured for 7 days.
- AA. Position bottom of fabric 2 inches above finished grade.
- BB. Install bottom tension wire stretched taut between terminal posts.
- CC. Install support arms sloped outward unless shown otherwise on Drawings and attach barbed wire; tension and secure.
- DD. Support gates from gate posts. Do not attach hinged side of gate from building wall.
- EE. Install gate with fabric to match fence. Install minimum of two hinges on each gate, one latch per leaf, and catches.
- FF. Provide concrete center drop to footing depth and drop rod retainers at center of double gate openings.
- GG. Connect to existing fence at existing terminal post or existing line post converted to terminal post by installation of brace rails and brace rods, unless shown otherwise on Drawings.
- HH. Install posts with six (6) inches maximum clear opening from end posts to buildings, fences and other structures, unless shown otherwise on Drawings.

3.2 PRIVACY SLATS

- A. Install slat inserts in vertical-pattern woven through fence fabric, unless shown otherwise on the Drawings.
- B. For a chain link fence with slats, install slats vertically in the mesh openings such that the slats fit snugly.

3.3 ERECTION TOLERANCES

- A. [Section 01 45 00 - Quality Control](#): Tolerances.
- B. Maximum Variation from Plumb: 1/4 inch.
- C. Maximum Offset from Indicated Position: 1 inch.

END OF SECTION 32 31 13

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SECTION 32 80 00 - IRRIGATION SYSTEM**PART 1 - GENERAL**

1.1 SUMMARY

- A. The CONTRACTOR shall provide all labor, materials, supplies, tools, and transportation and perform all operations in connection with and reasonably incidental to complete the installation of the automatic sprinkler irrigation systems as shown on the drawings. Items hereinafter are included as an aid to take off, and are not necessarily a complete list of work items.
1. Trenching, stockpiling, excavation, materials, and refilling trenches.
 2. Furnishing materials and installation for complete system including piping, valves, fittings, sprinkler heads, automatic controls, and final adjustment of heads to insure complete coverage.
 3. Line voltage connections to the irrigation controllers and low voltage control wiring from controllers to remote control valves.
 4. Replacement of unsatisfactory materials.
 5. Clean-up, inspection and approval.
 6. All work of every description mentioned in the specification and/or addenda thereto, all other labor, and materials reasonably incidental to the satisfactory completion of the work, including clean-up of the site, as directed by the Project Manager.
 7. Tests.
 8. Record drawings.
- B. Related Requirements:
1. [Section 01 29 00 - Payment Procedures](#)
 2. [Section 01 70 00 - Execution](#)
 3. [Section 01 77 00 - Closeout Requirements](#)
 4. [Section 31 23 16 – Utility Trenching](#)
 5. [Section 32 90 00 – Landscape Work](#)
 6. [Section 33 05 26 – Utility Identification](#)
 7. [Section 33 11 13 – Water Distribution Piping](#)
 8. [Section 33 12 00 – Water Distribution Equipment](#)
 9. [Section 33 12 13 – Water Service Connections](#)
 10. [Section 33 12 16 – Water Distribution Valves](#)

1.2 UNIT PRICE - MEASUREMENT AND PAYMENT

- A. [Section 01 29 00 - Payment Procedures](#): Contract Sum/Price modification procedures.
- B. Irrigation System:
 - 1. Measurement: Irrigation system installation is measured on a lump sum basis.
 - 2. Payment: The contract lump sum price paid for the Irrigation System shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in furnishing and installing the Irrigation System, complete in place.

1.3 SUBMITTALS

- A. [Section 01 33 00 - Submittal Procedures](#): Requirements for submittals.
- B. Product Data: Submit manufacturer catalog information on all material to be used on the project as specified on the legend, notes, details and plans. Redline or highlight exact items on page to be submitted. Complete material list shall be submitted prior to performing any work.
- C. Substitutions: No substitution will be permitted without prior written approval by the Project Manager. If the product is approved and, in the opinion of the Project Manager, the substituted product does not perform as well as the specified product, the Contractor shall replace it with the specified product at no additional cost to the City.
- D. All equipment or materials installed or furnished without prior approval of the City may be rejected and the Contractor may be required to remove the equipment or material at their own expense.

1.4 CLOSEOUT SUBMITTALS

- A. [Section 01 78 00 - Closeout Submittals](#): Requirements for submittals.
- B. Project Record Documents: The Contractor shall maintain in good order in the field office, one complete set of black line prints of all sprinkler drawings which form a part of the contract, showing all water lines, electrical, sprinklers, valves, stub-outs. In the event any work is not installed as indicated on the drawings, such work shall be corrected and dimensioned accurately from the building walls. All underground stub-outs for future connections and valves shall be located and dimensioned accurately from building walls on all record drawings. In addition to the hard copies a full sized scanned PDF will be required at completion.
- C. Controller Chart:

1. Provide one laminated controller chart showing the area covered by controller for each automatic controller supplied at the maximum size controller door will allow. Chart shall be a reduced drawing of the actual "as-built" system. If controller sequence is not legible when the drawing is reduced to door size, the drawing shall be enlarged to a size that is readable and placed folded, in a sealed plastic container, inside the controller door.
 2. Controller chart shall be a blackline print with a different color used to show area of coverage for each station. Charts must be completed and approved by the Project Manager prior to final inspection of the irrigation system.
- D. Maintenance and Operating Instructions and Manuals:
1. Contractor shall prepare an Operation and Maintenance Manual, organized in a 3-ring binder, containing the following information.
 - a. Contractor's name, address, and telephone number. Duration of guarantee, periods as specified herein, list of equipment with names and addresses of local manufacturer's representatives with duration of written warranties. Complete operating and maintenance instructions on all equipment spare parts lists and related manufacturer's information.
 2. Submit the Operation and Maintenance Manual to the Project Manager within 10 Calendar Days of completion of work of this Section and as a condition of project acceptance.
- E. SiteOne Green Tech controller certification:
1. Contractor shall coordinate with SiteOne Green Tech to have each controller certified after installation. A certification letter shall be provided to the Project Manager upon completion of project. Irrigation Controller shall be EPA WaterSense® approved.

1.5 QUALITY ASSURANCE & GENERAL REQUIREMENTS

- A. Qualifications: The Contractor, personally or through an authorized and competent representative, shall supervise the work constantly, and shall as far as possible keep the same foreman and workmen on the job from commencement to completion. The workmanship of the entire job must in every way be first class, and only experienced and competent workmen will be allowed on the job. A minimum of five years' experience of installing irrigation systems of similar scope, size and complexity as the system being installed under this scope of work is required for all on-site job superintendents.
- B. Manufacturer's installation instructions and best practices: Manufacturer's installation instructions shall be followed in all cases when not shown in the Drawings or Specifications.
- C. O.S.H.A. Compliance: All articles and services covered by this specification shall meet or exceed the safety standards established under the Federal Occupational

Safety and Health Act of 1970, together with all amendments in effect as of the date of this specification.

- D. All irrigation systems shall be installed to meet or exceed the requirements set forth in the California Department of Water Resources Model Water Efficient Landscape Ordinance.
- E. All irrigation systems shall be installed to meet or exceed the requirements set forth in Bay Friendly Landscape Guidelines.
- F. Codes and Standards: Comply with all applicable codes and standards.
 - 1. All work and materials shall be in full accordance with the latest rules and regulations of the National Electric Code; published by the Western Plumbing Officials Association; and other State or local laws regulations. Nothing in these drawings or specifications is to be construed as to permit work not conforming to these codes.
 - 2. When the specifications call for materials or construction of a better quality or larger size than required by the above mentioned rules and regulations, the provision of the specifications shall take precedence over the requirements of said rules and regulations.
 - 3. Contractor shall furnish, without extra charge, any additional material and labor when required by the compliance with these rules and regulations, though the work be not mentioned in these particular specifications or shown on the drawings.
 - 4. The Contractor shall erect and maintain barricades, guards, warning signs, and lights as necessary or required by O.S.H.A. regulations for the protection of the public or workmen.
 - 5. Any existing buildings, equipment, piping, pipe covering sewers, etc., damaged by the Contractor during the course of his work shall be replaced or repaired by the Contractor in a manner satisfactory to the Project Manager and at Contractor's own expense, before final payment is made. The Contractor shall be responsible for damage caused by leaks in the piping systems being installed or having been installed under this contract. He/she shall repair, at his/her own expense, all damage so caused, in a manner satisfactory to the Project Manager.
 - 6. The Contractor shall pay for all permits, licenses, and fees required.

1.6 EXISTING CONDITIONS

- A. Protection Of Existing Structures and Utilities
 - 1. The Drawings show, if applicable, existing above and below grade structures and utilities that are known to the City. Locate known existing installations before proceeding with construction operations that may cause damage to such installations. Existing installations shall be kept in service where possible and damage to them shall be repaired with no adjustment of Contract Sum. Verify with Project Manager if As Built drawings are available.

2. If other structures or utilities are encountered, request Project Manager to provide direction on how to proceed with the Work. If a structure or utility is damaged, take appropriate action to ensure the safety of persons and property.

- B. Trench Interference with Existing Tree Root Systems: Prior to trenching, layout main and lateral line locations within drip Line of trees and review locations with Project Manager. Relocate any lines that may interfere with existing root systems to avoid or reduce damage to root systems as accepted by Project Manager.

1.7 LAYOUT OF WORK

- A. The Contractor shall stake out the irrigation system as shown on the drawings. These areas shall be checked by the Contractor and Project Manager before construction is started. Any changes, deletions or additions shall be determined at this check.
- B. Due to the scale of the Drawings, it is not possible to indicate all piping offsets, fittings, sleeves, etc., which may be required. Carefully investigate the conditions affected all of the work and plan accordingly, and furnish all required fittings. Install system in such a manner to avoid conflicts with planting, utilities and architectural features.
- C. Do not install the irrigation system as shown on the Drawings when it is obvious in the field that obstructions, grade differences or discrepancies in arc dimensions exist that might not have been considered in Project Manager. Bring such obstruction or differences to the attention of the Project Manager. Notify and coordinate irrigation Work with applicable contractors for location and installation of piping and sleeves through or under walls, pavement and structures. In the event this notification is not given, the Contractor shall assume full responsibility for any revision necessary.

1.8 SEQUENCING AND SCHEDULING

- A. Acceptance: Do not install main line trenching prior to acceptance by Project Manager of rough grades completed under another Section.
- B. Coordination: Coordinate with the all other trades the sleeving, power requirements of the project, prior to the start of construction.

1.9 INSTRUCTION

- A. After the system has been installed and approved, the Contractor shall instruct the Project Manager in complete operation and maintenance of the irrigation system.

PART 2 - MATERIALS

2.1 PIPE AND FITTINGS

- A. Main lines (constant pressure); 4" and larger shall be polyvinylchloride (PVC) 1120-Class 200, ASTM D1785, Type 1, Grade 1 with rubber gasketed bell connections with ductile iron fittings with thrust blocks or joint restraints; 3" and smaller shall be PVC 1120-Schedule 40 plastic pipe. Pipe shall be made from NSF approved Type 1, Grade 1 PVC compound conforming to ASTM D1785.
 - 1. Join lengths of pipe by means of integrally formed bell end on pipe using rubber ring seal.
 - 2. Ring-tite main line: At changes in direction or branch mains, use appropriate Ductile Iron rubber ring seal fittings with thrust blocks or joint restraints.
 - 3. Solvent weld main lines: At changes in direction or branch mains, use appropriate Schedule 40 PVC solvent weld fittings as approved by the Uniform Plumbing Code.
- B. All piping for recycled water systems shall be manufactured from purple-colored PVC material and shall be printed on two sides with the wording "CAUTION-RECLAIMED WATER". Refer to Delta Diablo specifications for requirements.
- C. Lateral lines (non-pressure): 3/4" and larger shall be 1120-Schedule 40 PVC plastic pipe. All lateral lines shall be connected with Schedule 40, Type I, Grade I, PVC solvent weld fittings.
- D. Irrigation Sleeves shall be 1120-Schedule 40 PVC plastic pipe. Irrigation pipe and wires crossing beneath hardscape surfaces shall be contained within sleeving and Schedule 40 PVC conduit. Provide a minimum of one sleeve for water lines and a minimum of one Schedule 40 PVC electrical conduit for control wires. Sleeving size shall be a minimum of two times the aggregate diameter of all pipes contained within sleeve. Provide vertical sweeps for all electrical conduit on each side of hardscape and terminate ends a minimum of 12" from hardscape surface.
- E. Connections between main lines and RCV's shall be of Schedule 80 PVC (threaded both ends) nipples and fittings.
- F. Risers shall be as follows:
 - 1. Rotary Sprinklers Schedule 80 PVC threaded nipples and Schedule 80 PVC ells as shown in the construction details.

2.2 BACKFLOW PREVENTION DEVICE

- A. Backflow prevention device shall be the reduced pressure type with gate valves, check valves, test cocks, reduced pressure chamber and air vent.
- B. Provide a freeze preventative blanket around backflow assembly. Blanket shall be green.

- C. All metallic pipe and fittings installed below grade shall be may be wrapped with an approved asphaltic tape.
- D. Backflow prevention device model shall be per City of Pittsburg standard equipment list. Size as shown on the drawings. Install backflow prevention device in accordance with City of Pittsburg standard detail.

2.3 BACKFLOW PREVENTION DEVICE ENCLOSURE

- A. Enclosure shall be sized to completely enclosure backflow device.
- B. Install enclosure device in accordance with City of Pittsburg standard detail.
- C. Enclosure model shall be per City of Pittsburg standard equipment list. Powder coated dark green. Size as shown on drawings.

2.4 PRESSURE REDUCING VALVE

- A. Pressure reducing valve shall be diaphragm type, bronze body, with bolt to adjust the downstream pressure.
- B. Pressure reducing valve shall reduce pressure in both flow and no-flow conditions.
- C. Pressure shall adjustable with a range of 25-75 PSI.
- D. Pressure reducing valve shall be per City of Pittsburg standard equipment list. Size as shown on drawings.

2.5 BOOSTER PUMP

- A. When static water pressure in the City water system is less than 55 psi or when the hydraulic analysis of a proposed irrigation system requires more pressure than available a booster pump is required.
- B. Booster pump shall be a prefabricated, self-contained, Variable speed, (VFD), horizontal centrifugal pump station with piping, valves, and enclosure. Controls will be an operator interface with software programming written specifically for the project specific pump requirements. Pump station shall have a formed and reinforced base platform and enclosure with lockable lid contains all manifolding, pumps, motors and control panels to provide an integral unit ready for easy installation.

2.6 MASTER CONTROL VALVE

- A. Master control valve shall be a normally closed 24 VAC solenoid actuated globe pattern valve.

- B. Valves shall be made of durable glass-filled nylon with a pressure rating of 200 PSI
- C. Valve shall have external and internal bleed for manual operation.
- D. Valve shall have a scrubber mechanism to clean the stainless steel screen.
- E. Valve shall be model shall be per City of Pittsburg standard equipment list. Size as shown on drawings.

2.7 GATE VALVES

- A. Gate valves 3" and smaller shall meet the following requirements:
 - 1. Valves shall be of stainless steel (304 or higher) construction with non-rising stem, cross handle and threaded connections.
 - 2. Valves shall be per City of Pittsburg standard equipment list. Size as shown on the drawings
 - 3. Install in 10" diameter plastic valve box as detailed.
- B. Gate valves 4" and larger shall meet the following requirements:
 - 1. Valves shall be cast iron with operating nut (2" square) and "O" ring connections for Class 200 PVC plastic pipe.
 - 2. Valves shall be per City of Pittsburg standard equipment list. Size as shown on the drawings.
 - 3. Install in 10" diameter plastic valve box as detailed.

2.8 QUICK COUPLING VALVES

- A. Quick coupling valves shall per City of Pittsburg standard equipment list. Use Rain Bird 44NP with purple covers for use with recycled water. Install in 10" diameter plastic valve box as detailed. Refer to Delta Diablo specifications for requirements.

2.9 CONTROLLERS

- A. Controller's size and model shall be as listed on the drawings.
- B. Final location(s) of controller shall be approved by the Project Manager.
- C. Controller requires 120v power. Maximum power output of controller is 2.0 amps.
- D. Controllers shall be RainMaster Evolution DX2 controller within a Strongbox Stainless Steel Top entry controller. All controllers shall have a high gain antenna installed adjacent to the enclosure for communication with City's central computer. Contact Site One Green Tech when purchasing.
- E. Controller shall have a preinstalled flow sensor terminal board.

- F. Install Controller and accessories per City and Manufacturer's details.
- G. Each controller shall be equipped with a built in radio remote receiver and one remote transmitter.

2.10 CONTROLLER COMMUNICATION CABLE

- A. All sites with multiple Rain Master DX2 controllers shall be connected together via communication cable. Cable shall be Rain Master model EV-CAB-COM
- B. Communication cable shall be installed within 1¼" Schedule 40 grey PVC with Schedule 40 fittings and Schedule 40 electrical long sweeps elbows at all changes in direction. Pull boxes shall be located a minimum of 200 feet on center, adjacent to controller, and at each change of direction. Use rectangular boxes for all pull boxes. Use Carson model 1419-12 with bolt down lid. Color shall be black. Heat brand box "PB". Text height of letters to be 2".
- C. Maximum distance of communication cable shall be 2000'.
- D. Splicing of cable between controllers is not permitted.

2.11 CONTROL WIRE

- A. Control wire shall be copper with U.L. approval for direct burial in ground, size #14-Common ground wire shall have white insulating jacket; control wire shall have insulating jacket of color other than white or yellow. Runs over 2,000 lineal feet shall be #12- AWG-UF 600-volt copper wire. Splices shall be made with 3M-DBY seal packs.
- B. Provide a separate ground wire for each controller.
- C. Provide a minimum of two spare control wires into each RCV box for future. Spare wires shall be yellow in color.
- D. Tracer wire shall be used on all pressure piping. Tracer wire shall be blue and suitable for direct burial and wet conditions. Refer to Section 33 05 26 for additional requirements.

2.12 ELECTRIC REMOTE CONTROL VALVES

- A. Electric remote control valves sizes shall be shown on drawings.
- B. Electric remote control valve shall be a normally closed 24 VAC solenoid actuated globe pattern valve.
- C. Valves shall be made of durable glass-filled nylon with a pressure rating of 200 PSI

- D. Valve shall have external and internal bleed for manual operation.
- E. Provide and install one Schedule 80 PVC FIPT threaded true union ball valve with EPDM O-rings on the upstream side of valve and one Schedule 80 union on the downstream side of valve. Match valve size when sizing ball valve and union.
- F. All electric remote control valves for dripline or drip systems shall include a wye filter with a 200 mesh stainless steel screen and pressure regulator on the valve or downstream of the valve.

2.13 IDENTIFICATION TAGS/TAPE

- A. Identification tags for all electric control valves shall be manufactured by Christy. Tag numbers shall match stationing in controller and as shown on as-built drawings. Provide one yellow station number tag for each electric control valve and an additional purple one for recycled water system as follows:
 - 1. Potable water systems: Christy ID.STD.Y1
 - 2. Recycled water systems: Christy ID.STD.Y1 and Christy ID.MAX.P2.RC006. Refer to Delta Diablo specifications for requirements.
- B. Identification tags for all quick coupling valves are ONLY required for recycled water systems. Tags shall be Christy model ID.MAX.P2.RC006. Refer to Delta Diablo specifications for requirements.
- C. Detectable tape shall be installed on all pressurized pipes greater than 2". Tape shall be placed above the centerline of the pipe, spanning the full length of the pipe, and be placed at a depth of 6" above the top of the pipe. Tape shall be 3" wide by 5 mil thick and manufactured for direct burial service. Use blue colored tape for potable irrigation and purple for recycled water systems. Standard imprints shall read "CAUTION WATER LINE BELOW" AND "CAUTION BURIED RECLAIMED WATER LINE BELOW".

2.14 VALVES BOXES

- A. ELECTRIC REMOTE CONTROL VALVE BOXES:
 - 1. All electric remote control valve boxes that service non-drip systems shall be installed within a Carson Model 1419-12 or 1324-12 plastic valve box with bolt down plastic lid. Size of box is dependent on the size of valve. Lid shall be marked: "Irrigation Control Valve." Color: Green.
 - 2. All electric remote control valve boxes that service dripline or drip systems shall be installed within a Carson Model 1324-12 plastic valve box with bolt down plastic lid. Lid shall be marked: "Irrigation Control Valve." Color: Green.
 - 3. Use purple colored boxes with bolt down lid marked "RECLAIMED OR RECYCLED WATER" and with bilingual non-potable warning and symbol for all recycled water systems. Refer to Delta Diablo specifications for requirements.

4. Heat brand controller letter and numbers into lid. Minimum text height to be 2".

B. GATE VALVE AND QUICK COUPLING VALVE BOXES:

1. All gate valve and quick coupling valve shall be installed within a Carson Model 910-10 plastic valve box with plastic lid or approved equal. Use 8" sleeve to encase gate valve. Color: Green.
2. Use purple color boxes with bolt down lid marked "RECLAIMED OR RECYCLED WATER" and with bilingual non-potable warning and symbol. Refer to Delta Diablo specifications for requirements.
3. Heat brand the letters "GV" into lid. Minimum text height to be 2".

C. DRIP COMPONENT BOXES:

1. All drip components shall be installed within a 6" round black plastic valve box with plastic lid.
2. Use purple color lid with non-hinged bolt down lid marked "RECLAIMED OR RECYCLED WATER" and with bilingual non-potable warning and symbol. Refer to Delta Diablo specifications for requirements.

2.15 SPRINKLER HEADS AND BUBBLERS

- A. All sprinkler heads shall be as listed on the drawings. Refer to City of Pittsburg standard equipment list for make and model of pop-up rotary and spray sprinklers.
- B. Pop-up spray sprinklers shall include a built in check valve in the body to hold up to 14 feet of head.
- C. Pop-up spray sprinklers shall include built in pressure regulation in the body.
- D. Use built in 30 psi regulators for all spray nozzles and 45 psi regulators for all rotating nozzles. Use 12" pop-ups in shrub and ground cover areas and 6" pop-ups in turf areas.
- E. Riser units and nipples shall be the same size as the inlet to the sprinkler body.
- F. Use purple caps on sprinkler head for recycled water systems. Refer to Delta Diablo specifications for requirements.

2.16 DRIPLINE & DRIPLINE COMPONENTS

- A. Dripline shall be as listed on the drawings. Refer to City of Pittsburg standard equipment list for model number.
- B. Tubing shall be low density, UV resistant, polyethylene tubing with 17mm in size with internal pressure-compensating, drip emitters impregnated into the tubing spaced at 12 or 18 inches

- C. The built in emitters shall be capable of delivering 0.6 gallons per hour per emitter.
- D. Use purple colored tubing for recycled water systems.
- E. All dripline systems shall have a manual flush valve at each isolated zone within the systems. Multiple flush valves may be required per drip zone.
- F. All dripline systems shall have air relief valve(s) at the highest elevation point(s) within each isolated zone. Install one air relief valve for every 500 linear feet of dripline.

2.17 FLOW SENSORS

- A. Inline flow sensors shall be installed in accordance with the manufacturer's installation instructions. Contractor is responsible for the installation, all required materials and connections of the flow sensors for complete operation with the irrigation controller.
- B. Flow sensor size and model shall be listed on the drawings. Contact Site One Green Tech for models numbers

2.18 FLOW SENSOR CABLE AND CONDUIT:

- A. Flow sensor wire shall be shielded cable model EV-CAB-SEN manufactured by Rain Master.
- B. Maximum cable distance from controller to flow sensor shall be 2000 ft.
- C. Install flow sensor cable in a 1" grey SCH 40 PVC conduit with long sweep elbows.
- D. Conduit and flow sensor cable shall be routed with mainline wherever possible. Install 18" below grade. Provide a minimum 6" separation between conduit and pressure main line.
- E. Provide 10" round grey electrical pull boxes a minimum of every 200 ft, at each change in direction and adjacent to each controller. Heat brand lid of pull box "FSB".

2.19 CHECK VALVE

- A. Spring check valve shall be Schedule 40 PVC with ½ lb spring and stem rated at 150 PSI.
- B. Model and size as shown on drawings.

2.20 MISCELLANEOUS INSTALLATION MATERIALS

- A. Solvent cement and primer for solvent weld joints shall be of make and type approved by manufacturer(s) of pipe and fittings. Cement shall be maintained at proper consistency throughout use.
- B. Lubricant for assembling rubber ring seal joints shall be of make and type approved by manufacturer of pipe.
- C. Pipe joint compound shall be non-hardening, non-toxic materials designed specifically for use on threaded connections in water carrying pipe. Performance shall be same as RectorSeal #5.

2.21 MISCELLANEOUS EQUIPMENT

- A. Provide all equipment called for by the drawings.
- B. Provide to the Project Manager, at completion of the maintenance period, three (3) each of all operating and servicing keys and wrenches required for complete maintenance and operation of all heads and valve. Include all wrenches necessary for complete disassembly of all heads and valves.

PART 3 - INSTALLATION

3.1 PREPARATION

- A. Schedule and coordinate placement of materials and equipment in a manner to effect the earliest completion of work in conformance with construction and progress schedule.

3.2 HANDLING AND STORAGE

- A. Protect work and materials from damage during construction and storage as directed by the Project Manager.
- B. Handle plastic pipe carefully; especially protect it from prolonged exposure to sunlight. Any section of pipe that has been damaged will be discarded and removed and replaced if installed.

3.3 LAYOUT

- A. Lay out work as accurately as possible in accordance with diagrammatic drawings.
- B. Where site conditions do not permit location of piping, valves and heads where shown, notify Project Manager immediately and determine relocation in joint conference.

- C. Prior to installation, the Contractor shall stake out the routing of all pressurized main lines and sprinkler heads for approval by Project Manager.
- D. Run pipelines and automatic control wiring in common trenches wherever practical.

3.4 EXCAVATING AND TRENCHING

- A. Excavation shall be in all cases ample in size to permit the pipes to be laid at the elevations intended and to permit ample space for joining.
- B. Make trenches for pipelines deep enough to provide minimum cover from finish grade as follows:
 - 1. 18" minimum cover over main lines to control valves and quick coupling valves.
 - 2. 18" minimum cover over control wires from controller to valves.
 - 3. 12" minimum cover over RCV controlled lateral lines to sprinkler heads.
- C. Restore surfaces, existing underground installations, etc., damaged or cut as a result of excavations, to original conditions in a manner approved by the Project Manager.
- D. Where other utilities interfere with irrigation trenching and pipe work, adjust the trench depth as instructed by the Project Manager.

3.5 ASSEMBLING PIPELINES

- A. All pipe shall be assembled free from dirt and pipe scale. Field cut ends shall be reamed only to full pipe diameter with rough edges and burrs removed.
- B. Install plastic pipe in accordance with manufacturer's recommendations.
- C. Install 3" wide detectable warning tape above all pressurized main lines as shown in the City standard "Irrigation System Trenching Detail". Refer to Section 33 05 26 – Utility Identification.
- D. Rubber Ring Seal Joint:
 - 1. Use factory made male end or prepare field-cut male end to exact specifications of factory made end.
 - 2. Carefully clean bell or coupling and insert rubber ring without lubricant. Position ring carefully according to manufacturer's instructions.
 - 3. Lubricate male end according to manufacturer's instruction and insert male end to specified depth. Use hands only when inserting PVC pipe.
 - 4. Thrust blocks shall be provided where necessary to resist system pressure on ring-tite pipe and fittings. Blocks shall be concrete and the size shall be based on an average soil safe bearing load of 700# per square foot.
 - 5. Form thrust blocks in such a manner that concrete comes in contact only with the fittings. Thrust blocks shall be between solid soil and the fittings.

C. Solvent Weld Joint:

1. Prepare joint by first making sure the pipe end is square. Then, de-burring the pipe end, and clean pipe and fitting of dirt, dust and moisture.
2. Dry insert pipe into fitting to check for proper sizing. Pipe should enter fitting 1/3 to 2/3 depth of socket.
3. Coat the inside socket surface of the fitting and the male end of the pipe with P-70 primer (manufactured by Weld-On). Then without delay, apply Weld-On 711 cement liberally to the male end of the pipe and also apply 711 cement lightly to the inside of the socket. At this time, apply a second coat of cement to the pipe end.
4. Insert pipe immediately into fitting and turn 1/4 turn to distribute cement and remove air bubbles. The pipe must seat to the bottom of the socket and fitting. Check alignment of the fitting. Pipe and fitting shall be aligned properly without strain to either.
5. Hold joint still for approximately thirty (30) seconds and then wipe the excess cement from the pipe and fitting.
6. Cure joint a minimum of thirty (30) minutes before handling, at least six (6) hours before allowing water in the pipe.

D. Threaded Joint:

1. Field threading of plastic pipe or fittings is not permitted. Only factory formed threads will be permitted.
2. Factory made nipples shall be used wherever possible. Field cut threads in metallic pipe will be permitted only where absolutely necessary. When field threading, cut threads accurately on axis with sharp dies.
3. All threaded joints shall be made up with pipe joint compound. Apply compound to male threads only.
4. Where assembling metallic pipe to metallic fitting or valve, not more than three (3) full threads shall show when joint is made up.
5. Where assembling to threaded plastic fitting, take up joint no more than one full turn beyond hand tight.
6. Where assembling plastic pipe, use strap type friction wrench only; do not use metal-jawed wrench.

E. Cap or plug openings as pipeline is assembled to prevent entrance of dirt or obstructions. Remove caps or plugs only when necessary to continue assembly.

F. Where pipes or control wires pass through sleeves, provide removable non-decaying plug at ends of sleeve to prevent entrance of earth.

3.6 REMOTE CONTROL VALVES

A. Install where shown on drawings and group together where practical. Limit one remote control valve per box. No exceptions!

B. Locate valve boxes 12" from and perpendicular to walk edges, buildings and walls. Provide 12" between valve boxes where valves are grouped together.

- C. Thoroughly flush main line before installing valves.
- D. Install in shrub or groundcover areas where possible.
- E. Label control line wire at each valve with an I.D. tag, indicating identification number of valve (controller and station number). Attach label to control wire.
- F. Flow control stems shall be adjusted or tuned per manufacturer recommendations.

3.7 AUTOMATIC CONTROL WIRE

- A. Run lines along mains wherever practical. Tie wires in bundles with pipe wrapping tape at 10' intervals and allow slack for contraction between strappings.
- B. Loop a minimum of three (3) feet of extra wire in each valve box; both control wire and ground wire.
- C. Connections shall be made by crimping bare wires with brass connectors and sealing with watertight resin sealer packs.
- D. Splicing will be permitted only on runs exceeding 2500'. Locate all splices at valve locations within valve boxes.
- E. Where control lines pass under paving, they shall pass through Schedule 40 electrical PVC conduit. Do not tape wire in bundles inside conduit.

3.8 AUTOMATIC CONTROLLER

- A. Provide and install automatic irrigation controller in approximate locations shown on drawings. The exact location will be determined on the site by the Project Manager. Provide conduit and wire and connect to 120 volt switch accessible to controller for ease of maintenance.
- B. Connect control lines to controller in sequential arrangement according to assigned identification number on valve. Each control line wire shall be labeled at controller with a permanent non-fading label indicating station number of valve controlled. Attach label to control wire.
- C. Provide each irrigation controller with its own independent low voltage common ground wire.
- D. Provide each pedestal controller with its own ground rod. Separate the ground rods by a minimum of eight feet. The ground rod shall be an eight foot long by 5/8" diameter U.L. approved copper clad rod or as recommended by controller manufacturer. Install no more than 6" of the ground rod above finish grade. Connect #8 gauge wire with a U.L. approved ground rod clamp to rod and back to ground screw at base of controller with appropriate connector. Make this wire

as short as possible, avoiding any kinks or bending. Install a minimum of 8' away from pedestal housing base unless otherwise noted.

3.9 BUBBLERS, SPRINKLER HEADS AND QUICK COUPLING VALVES

- A. Thoroughly flush lines before installing heads, bubblers or QCV's.
- B. Locate bubblers, heads and QCV's as shown in the drawings and details.
- C. Adjust sprinkler heads for proper distribution and trim.
- D. Install lawn heads 1" above grade in seeded lawn area at time of installation. Lower to finished grade after turf is well established and as directed by Project Manager.

3.10 DRIPLINE AND DRIPLINE COMPONENTS

- A. Thoroughly all flush lines driplines.
- B. Install dripline a minimum of 12" away from all buildings and 6" off hardscapes for shrubs and groundcover. 2" of paving for all no-mow or sod type grasses.
- C. Space driplines equally throughout the planting area as detailed. Refer to legend for emitter and row spacing of dripline. Adjust alternate rows so emitters are spaced in a triangular pattern.
- D. All dripline tubing shall be buried 3" below finish grade and stapled down every 4' and at each change in direction with a 6" tubing stake.
- E. For slopes greater than 10:1, modify dripline row spacing on the bottom 1/3 of the slope to be 25% greater at the bottom of the slope.
- F. Install flush valves at the low end of each drip zone minimum of 2 valves are required for each valve. Refer to manufacturer details for installation instructions.
- G. Install air vacuum relief valve(s) at high point(s) of each planting area. Refer to drawings for approximate locations. Revise locations in field based on actual grades of the site. Locate 1 valve per every 500' of dripline. Refer to manufacturer details for installation instructions.
- H. Thoroughly saturate soil prior to planting. Provide additional surface watering as required to keep plant root systems moist during planting establishment period.

3.11 BACKFILLING

- A. Backfill only after piping and wire has been inspected and approved.
- B. Sand bed all pressurized mainlines as shown in the City standard "Irrigation System Trenching Detail"

- C. Backfill material shall be the earth excavated from the trenches, free from rocks, concrete chunks, and other foreign or coarse materials. The pH value of all backfill material shall be tested to be within 6.5 to 7.5 range.
- D. Place backfill materials in 6" layers and compact by tamping to a minimum compaction of 90 percent of original soil density.
- E. Dress off areas to finish grade and remove excess soil, rocks, or debris remaining after backfill is completed.
- F. If settlement occurs along trenches, and adjustments in pipes, valves, and sprinkler heads, soil, sod, or paving are necessary to bring the system, soil, sod, or paving to the proper level or the permanent grade, the Contractor, as part of the work under this contract, shall make all adjustments without extra cost to the City.

3.12 FIELD QUALITY CONTROL

A. Coverage Tests:

- 1. Perform coverage tests in the presence of Project Manager, after sprinkler or drip system is completed. Test system to assure that all areas are irrigated completely and uniformly.
- 2. Do not spray onto pavement or structures. Adjust arc nozzles as needed to provide full coverage without over spray.

B. Adjusting and Cleaning:

- 1. System adjustment:
 - a. Valves: Adjust flow for proper operation.
 - b. Heads: Adjust for alignment and coverage.
 - c. If it is determined that coverage could be improved by adding additional driplines or a nozzle change, make such changes as required to provide adequate coverage to all plant material.
 - d. Perform final cleaning of all risers, dripline, heads, and equipment for proper operation. Demonstrate operation and uniform coverage in the presence of the Project Manager prior before final acceptance.

3.13 TESTING

Perform test as specified below. Remake any faulty joints with all new materials. Use of cement or caulking to seal leaks is absolutely prohibited.

Contractor shall:

- A. Notify the Project Manager at least three (3) days in advance of testing.
- B. Perform testing at his/hers own expense.
- C. Center load piping with small amount of backfill to prevent arching or slipping under pressure. No fitting shall be covered

- D. Apply the following tests after welded plastic pipe joints have cured at least twenty-four (24) hours.
1. Ring-Tite Mainline: Remove all the air from the piping system then test live (constant pressure) and QCV lines hydrostatically at 125 PSI minimum. Lines will be approved if test pressure is maintained for two (2) hours. Maintain pressure during this time period and measure the amount of water required to maintain that test pressure. Approved tables of allowable loss are below, and the line will be approved or not approved as such results may indicate. The Contractor shall make tests and repairs as necessary until test conditions are met.

Allowable leakage for PVC plastic pipe with elastomeric joints in U.S. gallons per hour at a test pressure of 150 PSI.
 - a. 4" - 0.30 gallons per 1000 ft. or 50 joints
 - b. 6" - 0.45 gallons per 1000 ft. or 50 joints
 - c. 8" - 0.60 gallons per 1000 ft. or 50 joints
 2. Solvent Weld Mainline: Remove all the air from the piping system then test live (constant pressure) and QCV lines hydrostatically at 125 PSI minimum. Lines will be approved if test pressure is maintained for six (6) hours. The lines shall be restored to the original test pressure. The Contractor shall make tests and repairs as necessary until test conditions are met.
 3. Test RCV controlled lateral lines with water at line pressure and visually inspect for leaks. Retest after correcting defects.

3.14 MAINTENANCE

- A. Continuously maintain irrigation system in areas indicated in the Contract during the progress of work and for a period of **90 days** after substantial completion.
- B. It is Contractor's responsibility to turn over the irrigation in a first-class condition at the end of the maintenance period.
- C. Maintenance Schedule: Contractor shall submit schedule of maintenance tasks to be performed for City review and approval. At a minimum, maintenance staff shall be on-site two times per month. It is not the intention of these Specifications to allow a "quick cleanup" at the end of the maintenance period, but rather that the work be continuous and ongoing.
- D. Proper irrigation system maintenance includes the overall supervision of the system, controller scheduling, routine adjustments and necessary repairs.
- E. Maintain irrigation system for optimum performance, as per manufacturer's specifications, by inspecting the entire system on an on-going basis. This includes cleaning and adjusting all sprinkler, bubbler heads, drip and drip tube emitters and valves for proper coverage

3.15 GUARANTEE

- A. It shall be the responsibility of the Contractor to fill and repair all depressions and replace all necessary lawn and planting due to the settlement of irrigation trenches for one year following completion and acceptance of the job.
- B. The Contractor shall also guarantee all materials, equipment and workmanship furnished by him to be free of all defects of workmanship and materials, and shall agree to replace at his expense, at any time within one year after installation is accepted, any and all defective parts that may be found.

3.15 CLEAN-UP

- A. When work of this section has been completed and at such other times as may be directed, remove all trash, debris, surplus materials, and equipment from site.

END OF SECTION 32 80 00

SECTION 32 90 00 - LANDSCAPE WORK**PART 1 - GENERAL**

1.1 SUMMARY

- A. The CONTRACTOR shall provide all materials, equipment, and labor necessary to furnish and install the planting as shown on the Drawings and herein specified.
- B. Related Requirements:
 - 1. [Section 01 29 00 - Payment Procedures](#)
 - 2. [Section 01 70 00 - Execution](#)
 - 3. [Section 01 77 00 - Closeout Requirements](#)
 - 4. [Section 32 80 00 - Irrigation](#)

1.2 UNIT PRICE – MEASUREMENT AND PAYMENT

- A. [Section 01 29 00 - Payment Procedures](#): Contract Sum/Price modification procedures.
- B. Planting
 - 1. Measurement: Measurement for landscape planting shall be as provided in the bid proposal.
 - 2. Payment: The contract lump sum or unit prices shall include full compensation for furnishing all labor, materials, tools and equipment and performing all work necessary to complete the landscape installation work as shown and specified in the contract documents.
- C. Landscape Maintenance
 - 1. Measurement: Measurement for landscape maintenance shall be as provided in the bid proposal.
 - 2. Payment: The contract lump sum shall include full compensation for furnishing all labor, materials, tools and equipment and performing all work necessary to maintain the planting and irrigation work as shown and specified in the contract documents.

1.3 DEFINITIONS

- A. Bay-Friendly Landscaping (BFL) is a holistic approach to design, construction and maintenance of the landscape in order to support the integrity of the San Francisco Bay watershed ecosystem. BFL practices foster soil health, conserve water and other valuable resources while reducing waste and preventing pollution. BFL practices incorporated in these specifications are designated as **(BFL Practice)**. Additional Bay-Friendly resources are available at www.rescapeca.org/resources/publications-list

- B. Compost: An organic matter resource that is the product of controlled biological decomposition of organic materials, often including urban plant debris and food waste. Compost contains plant nutrients but is typically not characterized as a fertilizer. It has the unique ability to improve chemical, physical and biological characteristics of soils or growing media. (Excerpted from US Compost Council, Field Guide to Compost Use).

1.4 REFERENCE STANDARDS

D. Reference Standards:

1. American Standard for Nursery Stock (ANSI) - ANSI A300: Tree, Shrubs and Other Woody Plant Maintenance - Standard Practices, current edition.
2. ANSI Z133.1: Tree Care Safety Standards, current edition.
3. **BASMAA-SBF**: Bay Area Stormwater Management Agencies Association Specification of Soils for Biotreatment or Bioretention Facilities, dated April 18, 2016, or most current edition.
4. International Society of Arboriculture (ISA) Tree Pruning Guidelines, current edition.
5. U.S. Composting Council (USCC) Seal of Testing Assurance (STA) Program assures that compost producers have regularly tested compost for chemical, physical and biological properties. www.compostingcouncil.org

E. Related Documents:

1. California Model Water Efficient Landscape Ordinance (MWELO), updated July 2015, or current edition.
2. Bay-Friendly Landscape Guidelines describing the principles and practices in sustainable landscape construction and maintenance. Bay-Friendly publications and resources are available on-line at www.rescapeca.org/resources/publications-list.
3. Cal-Trans 'Storm Water Quality Handbooks' - Construction Site Best Management Practices (BMP's) Manual, current edition.

1.5 SUBMITTALS AND SAMPLES

A. References

1. [Section 01 33 00 - Submittal Procedures](#): Requirements for submittals.
2. [Section 01 78 00 - Closeout Submittals](#): Requirements for submittals.

B. Product Data & Schedules: Furnish manufacturer's literature, laboratory analytical data (soil analysis results and amendment recommendations) as required in this specification section, samples as noted, and schedules for the following items:

1. Planting fertilizer(s)
2. Composted Greenwaste Organic Amendment (**BFL Practice**)
3. Mulch (two one-quart samples) (**BFL Practice**)
4. Import topsoil (two one-quart samples)
5. Bioretention Soil (two one-gallon samples)

6. Nursery invoices for all plant material for this project
 7. Pesticide(s)
 8. Maintenance Schedule
- C. Substitutions: Plant Material Substitutions of plant material shall not be permitted unless authorized in writing by the Landscape Architect / Project Manager. If proof is submitted that specified plant material is not available, a proposal will be considered for use of the nearest equivalent size or variety with an equitable adjustment of contract price. These provisions shall not relieve Contractor of the responsibility of obtaining specified materials in advance if special growing conditions or other arrangements must be made in order to supply specified materials.
- D. Closeout Submittals
1. As-built drawings (hard copy and PDF-format scanned images) shall be provided as part of the closeout submittals.
- E. The Landscape Architect / Project Manager reserves the right to take and analyze samples of materials for conformity to specifications at any time. Contractor shall furnish samples upon request of the Project Manager. Rejected materials shall be immediately removed from the site at Contractor's expense. Costs of testing materials not meeting specifications shall be paid by Contractor.

1.6 QUALITY ASSURANCE

- A. Contractor Qualifications: Provide sufficient experienced workmen and supervisors who shall be present at all times during execution of this portion of work and who are thoroughly familiar with the type of construction, materials and methods involved. In the acceptance or rejection of the work, no allowance will be made by City for lack of workmen's skill.
- B. Requirements of Regulatory Agencies:
1. Obtain and pay for all licenses and permits and pay all inspection and other fees connected with the work.
 2. Conform to requirements of applicable Federal, State and local agencies. Nothing in the Contract Documents is to be construed to permit work not conforming to these requirements. Furnish without extra charge any additional material and labor required by above.
 3. Where conflict exists between requirements of above agencies and/or these Specifications, the more restrictive shall govern.
 4. All plants and planting material shall meet or exceed the Specifications of Federal, State, and local laws requiring inspection for plant disease and insect control. All inspection certificates required shall accompany shipments.

- C. Source Quality Control: Quality and size shall conform to current edition of "USA Standard for Nursery Stock" for number one grade nursery stock as adopted by American Associations of Nurserymen. In all cases, botanical names shall take precedence over common names.

1.7 QUANTITIES

- A. Plant material quantities indicated on the Drawings are for estimating purposes only. Furnish and install all plant materials as indicated - drawn quantities shall supersede numerical quantities.

1.8 DELIVERY, STORAGE AND HANDLING

- A. [Section 01 60 00 - Product Requirements](#): Requirements for transporting, handling, storing, and protecting products.
- B. Deliver all items to the site in their original containers with all labels intact and legible. Protect plants at all times from sun or drying winds as necessary or until planted. Do not handle plants by stems, trunks or tops, but only by container.

1.9 SITE CONDITIONS

- A. Contractor shall familiarize himself with existing site conditions as they may affect his work.
- B. Water will be provided at the site at no cost to Contractor. Make and remove temporary lines and connections as necessary for the proper execution of the work.

1.10 WARRANTY PERIOD

- A. All trees, shrubs, vines and ground covers shall be guaranteed to take root and thrive for a period of one year after FINAL ACCEPTANCE date.
- B. Plants shall be free of dead or dying branches and branch tips, and shall bear foliage of normal density, size and color. All dead plants, all plants not in a vigorous growing condition and plants exhibiting conditions unacceptable due to actions during planting and maintenance operations, as determined by Landscape Architect / Project Manager, shall be replaced immediately by Contractor at no additional cost to the City. Replacement shall closely match size and habit of adjacent specimens of the same species and shall be subject to all requirements of the Specifications.
- C. Contractor shall not be responsible for failures due to neglect by the City, vandalism, abuse or damage by others, or unusual phenomenon or incidents

above and beyond the Contractor’s control, during Warranty Period. Report such conditions to the City in writing.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Fertilizers, Soil Amendments and Mulch: First quality, standard brand, agricultural products. Deliver in original containers with brand name marked thereon. Furnish City with all certificates or delivery slips for each material delivery in containers or in bulk.

1. Commercial Fertilizer: A complete control-release fertilizer in pellet form of which part of the elements are derived from organic sources:
16% Nitrogen, 16% Phosphoric Acid and 16% Potash
Plant Fertilizer Paks: Best-Paks 20-10-5 planter paks.
2. Soil Sulfur: Agricultural grade Sulfur containing minimum of 99% Sulfur (expressed as elemental).
3. Ammonium Sulfate, 21-0-0
4. Iron Sulfate: 20% iron (expressed as metallic iron) derived from ferric and ferrous sulfate, 10% sulfur (expressed as elemental).
5. Potassium Sulfate, 0-0-50.
6. Calcium Carbonate: 95% lime derived from oyster shells.
7. Gypsum: Agricultural grade with 98% Calcium Sulfate.
8. Sulfur Coated Urea (SCU): SCU 21-7-14 or SCU 21-7-7.
9. Composted Organic Greenwaste Amendment (**BFL Practice**): Yard waste compost free of contaminants with pH of 5.5-8.0, minimum organic content of 250 pounds per cubic yard of compost (minimum 50% of compost’s dry weight, TMECC 05.07-A), 35-60% moisture content, maximum 4.5 dS/m Ece, salinity measured on the saturation extract solution shall not exceed 8.0 dS/m, 8 or below carbon dioxide evolution rate (TMECC 05.08-B), greater than 80% seedling emergence maturity bioassay (TMECC 05.05-A), and a minimum of 90% of the material by weight shall pass a ½" screen. Material passing the ½" screen shall meet the following criteria:

<u>Sieve Designation</u>	<u>Percent Passing</u>
9.51 mm (3/8")	85-100%
2.38 mm (No. 8)	50-80%
500 micron (No. 35)	0-40%

- Composted Organic Amendment shall have ‘STA’ certification from U.S. Composting Council (USCC).
- Provide sample (two one-quart size) certificate of conformance and current analysis for approval.

Approved products include WM EarthCare “Homegrown Compost” (877.963.2784); BFI Organics “Super Humus” compost (408.687.1928); Z-Best Organic Compost (408.263.2384); “Premium Compost” by Recology Blossom Valley Organics (209.872.0734), or equal.
(verify products)

10. Mulch: 100% recycled, clean, untreated lumber coarsely ground to 2” minus, and dyed with colorfast, natural dye with 1-year color retention; no ground wood stumps or branches. “Mission Mahogany” by WM EarthCare (877.963.2784), or equal.
 - Submit samples (two one-quart size) for approval.

B. Soils

1. "On-Site" topsoil: Topsoil from the site without admixture of subsoil, free from rocks, clay or foreign matter.
 - a. Soil Testing: Obtain soil analysis and recommendations from Waypoint Analytical, San Jose, (408)727-0330, for approval prior to planting. At a minimum, soil analysis shall include soil texture, infiltration rate determined by laboratory test or soil texture infiltration rate table, PH, total soluble salts, sodium, essential nutrients and percent organic matter. Recommendations shall reflect amending soil with compost to bring the soil organic matter to a minimum of 5% by dry weight and incorporating fertilizers to recommended levels for planting area.
 - b. Amendments, fertilizer rates and quantities listed under Item 3.2K-Soil Amendment are to be used for bid basis only. Adjust the quantities of soil amendments and fertilizer per soil report. Contractor shall be reimbursed for additions as approved by Project Manager.
2. "Import" Topsoil: "Import" Topsoil: Fertile, friable local natural sandy loam or loam, free from weeds, seed, stones, subsoil or other debris and complying with the following:

a. Physical Properties:

<u>Class</u>	<u>Particle size range</u>	<u>maximum, % wt.</u>	<u>minimum, % wt.</u>
Coarse sand	0.05-2.0 mm	15	0
Silt plus clay	<.05 mm	50	25
Silt	0.002-0.05 mm	30	10
Clay	0-0.002 mm	20	10
<u>Other Classes</u>			
Gravel	2-13 mm	15	0
Rock	>½ inch	10% by volume	0
	none>1 inch		
Organic matter		15	0

If the native subgrade texture is within specified limits, the import topsoil texture should be as similar as practical to that material to minimize interfacing concerns.

- b. Chemistry: pH shall be between 5.5 and 7.5 without high qualitative lime content and boron shall not exceed 1 part per million as measured on a saturation extract. Salinity ECe shall be less than 3.0 dS/m @ 25 degrees C. and sodium adsorption ratio (SAR) shall be less than 6.0.
- c. Fertility Considerations: Soil to contain sufficient available nitrogen, phosphorus, potassium, calcium and magnesium to support normal

plant growth. In the event of nutrient inadequacies, provisions shall be made to add required materials prior to planting.

- d. Sample: Submit samples (two one-quart size) with a soil analysis and recommendations from Waypoint Analytical for approval.
3. Bioretention Soil: A mixture of fine sand and compost, conforming to **BASMAA-SBF**, shall provide a long-term, in-place infiltration rate of at least 5 inches per hour, shall support vigorous plant growth and consist of the following mixture, measured on a volume basis: 60-70% Sand, 30-40% Compost.
 - a. Submit Requirements per **BASMAA-SBF**:
 - Sample of mixed Bioretention Soil (one-gallon size).
 - Certification that the Bioretention Soil meets the guideline specification requirements.
 - Grain size analysis results of the fine sand component.
 - USCC STA quality analysis results for compost.
 - Organic content test results of mixed Bioretention Soil.
 - Grain size analysis results of compost components.
 - Description of equipment and methods used to produce Bioretention Soil.
 - b. Suppliers producing Bioretention Soil found to meet and/or exceed the Guideline Specifications are:
 - LH Voss Materials, 925.560.9920
 - Contra Costa Topsoil, Martinez, 925.228.4007

C. Plants:

1. Furnish plant materials to complete work as indicated on Drawings and as specified.
2. Plants shall be typical for variety and species; healthy, vigorous, free from disease and insects, with healthy normal root systems, filling their containers, but shall not be rootbound.
3. Plants shall be subject to review and approval by the Landscape Architect / Project Manager at place of growth and upon delivery for conformity to Specifications. Such approval shall not impair the right of review and rejection during progress of the work.
 - a. Submit written request for review of plant material at place of growth to the Project Manager. Written request shall state the place of growth and quantity of plants to be inspected. The Landscape Architect / Project Manager reserves the right to refuse review at this time if, in his judgment, a sufficient quantity of plants is not available for review.
 - b. Inspection for approval or rejection is reserved for the project site upon delivery. Plants shall be inspected for size, variety, condition, root system and defects. Any rejected material shall be promptly removed from site. Notify Project Manager 48 hours prior to inspection.
4. Sod: As noted on the Drawings. Sod shall be machine cut at a uniform thickness. It shall be harvested, delivered and planted within 30 hours. Individual slabs shall be no larger than 9 sq. ft. and shall be weed free.

D. Supplies:

1. Tree Stakes: Lodgepole Pine tree stakes; untreated chamfered top and bottom.
2. Tree Ties: Cinch-Tie, UV resistant, virgin flexible black vinyl meeting ASTM-D-412 standards for tensile elongation strength. Ties shall have a double back locking configuration and secured with one galvanized screw to prevent slippage. Manufacturer: V.I.T. Products, 800.729.1314.
3. Tree Drains: Flexible corrugated perforated plastic drain pipe, 4" diameter. Tree drain to extend 6" deeper than tree rootball, 18" minimum length. Backfill with ¾" drain rock.
4. Root Barrier: #UB 24-2 polypropylene plastic barrier. Manufacturer: Deep Root Corp. available through Ewing 510-687-3220.
5. Water Barrier: WB24/30 24/40 24/60 24/80 24" depth polyethylene (HDPE), 0.030" (0.76 mm) thickness, by Deep Root Corp.
6. Pesticides: Product and application rates to conform to manufacturer's recommendations and as approved by City IPM Coordinator. Notify Project Manager 24-hours prior to application. City staff shall be present during application unless otherwise directed.
 - a. Pre-emergence Weed Control: Ronstar manufactured by Chipco
 - b. Broad Leaf Control: Trimec.
 - c. Grass Control: Poast (mix with oil concentrate emulsifier - No Foam Herbicide Activator) or Fusilade (mix with non-ionic surfactant).

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Prior to the work of this section, inspect existing grades and installed work of other trades and verify that planting may be completed in accordance with Contract Documents.
- B. Should sub-surface drainage or soil conditions (high water table, excessive compaction, etc.) be encountered which would be detrimental to growth or survival of plant material, notify Project Manager in writing, stating conditions and submitting a proposal covering cost of correction. If the Contractor fails to notify Project Manager of such conditions, he shall be responsible for plant material under the guarantee clause of this Section.

3.2 PREPARATION

- A. Layout of Work: Drawings are to be considered schematic unless specifically dimensioned. Check all Drawings and make work conform to all conditions shown thereon. Stake out exact plant locations on the job to suit actual conditions. Verify with Project Manager any variations prior to planting. Locations so determined are Contractor's responsibility and changes required because of such actions shall be by Contractor at no extra cost to City.

- B. Debris Removal: Remove all construction debris, base rock, refuse and paving material to full depth where occurs in planting areas.
- C. Plant Material Protection: Existing plant material to remain shall be protected from damage. Do not stockpile material or equipment within 25' of dripline. Trenching adjacent to roots shall be performed in accordance with the irrigation specs.
- D. Existing Plant Material to Be Removed: In order to accommodate proposed planting installation, remove existing plant material including vegetation, stumps, and roots 1" in diameter and larger to a depth of 2 feet below existing ground surface or to subgrade, whichever is deeper. Fill all stump and roots holes with import or on-site (see plan) topsoil in accordance with fill and compaction requirements.
- E. Plant Material Removal: All vegetation, stumps, and roots 1" in diameter and larger shall be removed 2 feet below existing ground surface or to subgrade, whichever is deeper. Fill all stump and roots holes with suitable material in accordance with fill and compaction requirements.
- F. Root Barrier: Provide as noted on Drawings. Install barrier per manufacturer's specifications and as detailed.
- G. Water Barrier: Provide water barrier at perimeter of all median planting areas. Provide as noted on Drawings. Install barrier per manufacturer's specifications and as detailed.
- H. Topsoil: "On-site Topsoil" shall be used where possible. If there is not sufficient soil available to meet finish grades, add "Import Topsoil" to complete grading.
- I. Bioretention Soil Installation: Conform to Civil Engineer's Drawings. Place soil in 8" to 12" lifts. Lifts are not to be compacted but are placed to reduce the possibility of excessive settlement. Allow time for natural compaction and settlement prior to planting. Bioretention Soil may be watered to encourage compaction.
- J. Topsoil Preparation: Do not work soil when moisture content is so great that excessive compaction will occur or when clods will not break readily. Apply water, if necessary, to bring soil to an optimum moisture content for tilling and planting.
 - 1. Grades shall conform to those indicated on the Drawings and herein specified. Do not place topsoil in the drip line of any existing tree.
 - 2. Cultivate all planting areas to 10" depth for continuous area of friable soil. Larger areas may be cultivated by ripping using tractor with downpressure on ripper shanks at 8" to 10" on center, or equivalent.
 - 3. Import topsoil shall be incorporated into top two inches (2") of existing site soil.
 - 4. Compact topsoil to 80% maximum relative compaction.

- K. Soil Amendment (excluding Bioretention Soil): After grading, cultivation, and topsoil placement has been completed and soil water settled, high and low spots regraded and rough grades approved by Project Manager, add soil amendment as indicated below and rototill until thoroughly mixed to six inch (6") depth.

AMOUNT/1,000 SQUARE FEET

6 Cubic Yards Composted Organic Amendment
20 Pounds 18-12-6 Commercial Fertilizer

- L. Planting Backfill at Tree and Shrub Planting Pits:

1. Shrubs (5 gallon and smaller): Utilize surface amended soil for planting backfill, full depth of plant pit.
 - a. At areas where soil amendment procedure is not required, amend soil at plant pits. Amend plant pit at the following rate: .33 cubic yards organic amendment per cubic yard of soil.
2. Shrubs (15-gallon size): See tree planting backfill as follows.
3. Trees:
 - a. 0-12" depth: Utilize surface amended soil.
 - b. 0-12" depth (areas where soil amendment procedure is not required): Amend soil at each plant pit. Amend upper 12" of plant pit at the following rate: .33 cubic yards organic amendment per cubic yard of soil.
 - c. Backfill below 12" depth:
Utilize native soil without amendment or additives.
Incorporate 1 pound 6-20-20 and 2 pounds iron sulfate per cubic yard of soil.

- M. Finish Grading:

1. Slope soil areas adjacent to buildings away from buildings. Surface drainage shall conform to Engineer's drawings.
2. Finish grades shall be uniform levels or slopes between points where elevations are given or established by paving, curbs or catch basins. Grades shall be smooth, uniform planes with no abrupt changes.
3. All grades shall provide for natural runoff of water without pockets. Accurately set flow line grades to a minimum of 2% gradient.
4. Finish grade for all planted areas shall be 1" below top of paving, curbs or walls unless indicated on Drawings.

3.3 INSTALLATION

- A. General:

1. Do not install plant material until all construction work has been completed and irrigation system installed and checked. Do not install planting during unfavorable weather.
2. Set all plants so that, when settled, the natural grade in the container is the same as the finished grade of planting area. All roots shall be covered and

no filling will be permitted around trunk. Water all plants at least 1/2 hour before planting and again after planting each plant.

B. Installation of Shrubs and/or Trees:

1. Locate plant material as indicated on the Drawings. Where material is indicated in a "loose" pattern, maintain an unequal, random spacing. Excavate holes for trees and shrubs to depths and widths as shown on details. Scarify bottom and sides of holes. Soils at bottom of plant pit shall be scarified to 8" depth to improve soil porosity. If rocky or shale soil is encountered, increase width and depth of plant hole by 6", and insure drainage.
2. Lift plant out of container carefully by the rootball. Place each plant in the center of plant hole. Spread out any exposed roots, do not fold under or bend up. Prune injured roots.
3. Place Plant Fertilizer Paks in backfill, 6"-8" under soil surface & 1" from rootball at all plants when planted. Apply paks at the following rate: one gallon - 1 Pak; 5 gallon - 3 Paks; 15 gallon - 9 Paks; boxed trees - 12 Paks.
4. Backfill with specified material and firmly tamp around the rootball to force out all air pockets. Water thoroughly.
5. If settlement occurs, lift plant or replant plants to finish flush with existing grade.
6. Form a circular earth watering basin centered on plant. Basin rim shall be 4" above finish grade at the trunk. Install 2" depth mulch at inside of basin. Basins shall be lifted around plants until winter, and then one side shall be broken to allow water passage.
7. Remove all nursery stakes and plant labels.

C. Mulch:

1. Mulch all planted areas (including Bioretention Facilities) with minimum 3" depth of mulch (**BFL Practice**), except that within plant basins mulch shall be 2" depth.
2. Hold mulch material a minimum four (4") inches away from rootcrown of tree and a minimum two (2") inches away from rootcrown of shrubs, perennials and ornamental grasses one (1) gallon size and larger. Mulch may be installed to the rootcrown of plant material smaller than one (1) gallon in size.
3. Install mulch immediately after plant installation.

D. Ground Cover Installation:

1. Prior to planting ground cover, install mulch in planting areas indicated on the Drawings.
2. Plant ground cover in designated areas at spacing shown on Drawings, in neat staggered rows, insuring complete coverage and including around shrubs and trees. After planting, smooth the soil around plants.

3. Water plants immediately after planting with a light spray until soil is saturated. Do not spray in hot direct sun. Do not allow plants to dry out before planting.
- E. Installing of Tree Stakes and Ties:
1. Double stake all trees as detailed on Drawings. Set stakes at right angles to prevailing wind. Drive stakes 2' into firm ground, set plumb. Do not drive stake through rootball.
 2. Tree Ties: Install per manufacturer's specifications, securing at stakes with galvanized screws.
 3. Set up a sample stake and ties for approval of Project Manager prior to installing tree stakes and ties.
- F. Vine/Espalier Installation: Remove stake support without damage to plant and train upon adjacent support as directed. Secure vine/espalier with plastic, ribbon or glue-on vine ties.
- G. Lawn Installation:
1. Do not install lawns until all construction and irrigation work has been completed. This includes cultivation and incorporation of soil amendment as specified.
 2. Rototill soil to 6" minimum depth. Remove all stones 3/4" or larger. Incorporate soil amendment as specified. Remove all stones 3/4" or larger.
 3. Bring lawn bed to grade by rolling, raking and dragging until surface is smooth and of a uniform fine texture.
 4. Sodding: Sod shall be as noted on the Drawings.
 - a. Sod shall be machine cut at a uniform thickness of 3/4" excluding top growth and thatch. It shall be harvested, delivered and planted within 30 hours. Individual slabs shall be no larger than 9 sq. ft. and shall be weed free.
 - b. Distribute SCU 21-7-14 commercial fertilizer over lawn areas at rate of 10 lbs. per 1000 sq.ft.; water thoroughly.
 - c. While areas are still damp, lay slabs tightly together without overlapping. Stagger rows of slabs.
 - d. Lightly roll sod with 200 lb. roller to obtain uniform grade. Correct any irregularities or settlement by lifting sod, regrading area and relay.
 - e. Water thoroughly to a depth of 8", and keep moist at all times until it has rooted into the soil.
 5. Seeding:
 - a. Lawn seed mix shall be as noted on Drawings. Seed application rate shall be 6 lbs. per 1000 square feet.
 - b. Seed shall be fresh, clean and new crop. Deliver to the site in sealed standard containers. All containers shall be labeled to show mixture and percentages of purity and germination of each variety of seed. No mixture shall contain more than 3.50% inert material and 10% weed

seed. Seed which has become wet, moldy or otherwise damaged in transit or storage will not be accepted.

- c. Sow seed during the windless period with an approved seeder, sowing $\frac{1}{2}$ of the amount in each direction.
- d. Distribute SCU21-7-14 commercial fertilizer over lawn areas at the rate of 10 lbs. per 1000 square feet and lightly rake surface to cover seed and to mix with fertilizer. Compact by rolling with 200 lb. roller.
- e. Wet seeded area slowly, but thoroughly, and keep moist at all times until germination.
- f. Contractor shall guarantee an even and uniform stand of grass and shall re-seed and maintain until such stand is produced.

3.4 CLEAN-UP Prior to pre-maintenance inspection, remove all debris, dirt, rocks, trash, etc. from paving, sidewalks, and other non-planter areas. Be prepared to wash all paved areas clean with either a water truck or fire hose or other large suitable equipment capable of accomplishing the work quickly.

3.5 PRE-MAINTENANCE INSPECTION

- A. Upon receipt of Contractor's written notification that all construction and installation work has been completed, a date for pre-maintenance inspection will be scheduled.
- B. All planting areas shall be free of weeds and neatly cultivated at time of inspection.
- C. Contractor, Project Manager, Landscape Architect and such others as the Project Manager directs shall be present at the inspection. If, after the review, the Landscape Architect / Project Manager is of the opinion that all work has been performed per the Contract Documents and that all plant materials are in satisfactory growing condition, the Contractor will be given a written notice of acceptance of the planting portions of the Work and commencement of the Maintenance Period.
- D. Work requiring corrective action or replacement shall be performed within 10 days after the Inspection. This work will not be accepted for the start of the maintenance period until all items noted as deficient during the inspection are corrected or completed. Corrective work and materials replacement shall be in accordance with the Plans and Specifications and shall be made by the Contractor at no cost to the City. Upon approval of work by Project Manager, maintenance period shall begin.

3.6 MAINTENANCE

- A. Continuously maintain all plantings and irrigation system in areas indicated in the Contract during the progress of work and for a period of **90 days** after substantial completion.
- B. It is Contractor's responsibility to turn over the landscaping in a first-class condition at the end of the maintenance period. All plants will be healthy and growing; the beds will be free from weeds and generally clean.
- C. Maintenance Schedule: Contractor shall submit schedule of maintenance tasks to be performed for City review and approval. At a minimum, maintenance staff shall be on-site two times per month. It is not the intention of these Specifications to allow a "quick cleanup" at the end of the maintenance period, but rather that the work be continuous and ongoing.
- D. Plant Material: Reset plants to proper grades or upright position. Replace, without cost to City, all dead, dying or missing plants with plants of a size, condition and variety acceptable to the Landscape Architect / Project Manager. Replacement plants shall be installed as soon as unacceptable condition is noted.
- E. Tree Staking: Check and adjust frequently to ensure that no tree damage is being caused. Remove stakes as soon as tree roots are established and trees are stable (typically after one full growing season).
- F. Weeding: Manually or chemically at Contractor's discretion and as approved by City.
 - 1. Pre-emergence control:
 - a. Four (4) days following the planting of the trees and shrubs, treat all exposed soil with Ronstar G or equal.
 - b. Exposed soil shall be defined as "that soil not planted with ground cover at least 6 inches away from a shrub rootball and 12 inches away from a tree rootball."
 - c. Pre-emergence materials shall always be applied prior to mulching of any kind.
 - 2. Post-emergence control:
 - a. Grass control: Apply in accordance with manufacturer's recommendations.
 - b. General broad spectrum control: Apply in accordance with manufacturer's recommendations. **NEVER SPRAY ON WINDY DAYS! APPLICATOR WILL BE RESPONSIBLE FOR REPLACEMENT OF ALL DAMAGED PLANT MATERIALS.**
- G. Fertilizing - Ground Cover/Shrub Areas: Apply ammonium sulfate (21-0-0) at the rate of 5 lbs per 1,000 sq. ft. of area in all ground cover areas at least once every 30 calendar days during the maintenance period, until final acceptance of Project Manager. Water thoroughly.

- H. Fertilizing - Lawn Areas: Apply SCU 21-7-14 fertilizer at the rate of 10 lbs per 1,000 sq. ft. 50 days after planting.
- I. Cultivation: All areas that are not covered with ground cover or mulch shall be kept cultivated. Perform this work in such a way as not to disturb feeder roots. Cultivating at least once a month in prominent areas close to entrance ways to keep the "fresh look" apparent. Do not cultivate until all trash and leaves are removed from planting beds.
- J. Insect and Disease Control: Contractor shall be prepared to effect a spraying program to control all infestations of insects, fungus diseases, etc. that could cause damage to the landscape. Inspection for spraying program shall be on the same schedule as fertilization.
- K. Rodent & Pest Control (If problems occur): Contractor shall be prepared to implement a pest management program to control rodents, rabbits, and ground squirrels that could cause damage to the landscape.
 - 1. Coordination with City staff for recommendations and approval.
 - 2. Utilize tamperproof trapping devices to control infestations where feasible. Submit product literature for City's review and approval.
 - 3. Utilize EPA-approved rodenticides applied at manufactured recommended rates. Submit literature for City's review and approval.
- L. Pruning: Pruning shall be kept to the minimum necessary for safety, improving long-term tree structure, and providing the necessary clearance for construction equipment. Remove crossover branching, developing co-dominant leaders and dead wood. Do not over prune or shear plants.
 - 1. All pruning shall be performed by a tree contractor possessing a State of California Contractor's License for Tree Service and supervised by a certified arborist. All operations shall be in accordance with the ISA pruning guidelines and adhere to ANSI Z133.1 and ANSI A300. Heading cuts shall not be used.
 - 2. Prune all trees once a year in the dormant season for thinning and shaping. In the spring at the start of growing season, remove unwanted sucker growth by "thumb" pruning.Pruning: Follow the standard pruning techniques recommended by the University of California at Davis Pruning Manual.
- M. Mowing: Lawns shall be mowed once a week during growing season and as required during dormant season.
- N. Watering: Automatic: Contractor is responsible for setting irrigation controller to apply enough water each week to keep the plantings moist--not too wet and not too dry. The amount of watering will vary with the season and location. Make sure through weekly examination of irrigation system that all heads are operating properly. See Section 32 80 00 for irrigation system maintenance.

3.7 FINAL ACCEPTANCE REVIEW

- A. Contractor shall request review in writing. Arrangements shall be made 48 hours in advance for final review at end of maintenance period.
- B. Contractor, Project Manager, Landscape Architect and such others as the Project Manager directs shall be present at the review.
- C. If, after the review, the Landscape Architect / Project Manager is of the opinion that all work has been performed per the Contract Documents and that all plant materials are in satisfactory growing condition, and the irrigation system is in operating order, the Contractor will be given a written notice of Final Acceptance Review, the end of the Maintenance Period, and commencement of the Warranty Period.
- D. Work requiring corrective action or replacement shall be performed within 10 days after the Final Acceptance Review. Corrective work and materials replacement shall be in accordance with the Plans and Specifications and shall be made by the Contractor at no cost to the City.
- E. No partial approvals will be given.

END OF SECTION 32 90 00

SECTION 33 05 13 - MANHOLES AND STRUCTURES**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Cast-in-place concrete manholes and structures with transition to cover frame, covers, anchorage, and accessories.
2. Modular precast concrete manholes and structures with tongue-and-groove joints and transition to cover frame, covers, anchorage, and accessories.
3. Bedding and cover materials.

B. Related Requirements:

1. [Section 03 30 00 – Utility Cast-in-Place Concrete](#): Concrete Forming and Accessories, Erection and bracing of forms.
2. [Section 03 30 00 – Utility Cast-in-Place Concrete](#): Concrete Reinforcing: Execution requirements for reinforcing steel as required by this Section.
3. [Section 03 30 00 – Utility Cast-in-Place Concrete](#): Concrete type for manhole and structure foundation slab construction.
4. [Section 31 05 13 – Clearing & Grubbing, Excavation, and Earthwork](#): Backfill.
5. [Section 31 23 16 – Utility Trenching](#): Excavating for manholes, structures, and foundation slabs.
6. [Section 33 01 30 – Testing for Sanitary Sewer, Storm Drainage – Piping and Manholes](#): Testing requirements for manholes.
7. [Section 33 05 17 – Precast Concrete Valve Vaults and Meter Boxes](#): Execution requirements for utility structures affected by this Section.
8. [Section 33 31 13 – Sanitary Sewer Piping](#): Piping connections to manholes.
9. [Section 33 41 13 – Storm Drainage Piping](#): Piping connections to manholes and structures.

1.2 UNIT PRICE - MEASUREMENT AND PAYMENT

A. [Section 01 29 00 – Payment Procedures](#): Contract Sum/Price modification procedures.

B. Manholes and Structures:

1. Basis of Measurement: Manholes, Catch Basin, Area Drains, Headwalls, Flare pipe end are measured by each. Structure bedding and backfill are

incidental to the bid item most closely related to and no separate compensation allowed therefor.

2. Basis of Payment: Includes excavating, all utility trenching work as specified in Section 31 23 16 – Utility Trenching, concrete foundation slab, concrete structure sections, bedding, backfill, concrete masonry structure construction, transition to cover frame, cover frame and cover to indicated design depth, forming, sealing pipe inlets and outlets and air testing of structures.

1.3 REFERENCE STANDARDS

A. American Association of State Highway Transportation Officials:

1. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications.
2. AASHTO M306 - Standard Specification for Drainage, Sewer, Utility, and Related Castings.

B. American Concrete Institute:

1. ACI 530/530.1 - Building Code Requirements and Specification for Masonry Structures.

C. ASTM International:

1. ASTM A48 - Standard Specification for Gray Iron Castings.
2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
3. ASTM C361 - Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.
4. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
5. ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
6. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.
7. ASTM C923 - Standard Specification for Resilient Connectors between Reinforced Concrete Manhole Structures, Pipes, and Laterals.

1.4 SUBMITTALS

- A. [Section 01 33 00 - Submittal Procedures](#): Requirements for submittals.
- B. Product Data: Submit data for manhole covers, component construction, features, configuration, and dimensions.
- C. Shop Drawings:

1. Indicate structure locations and elevations.
 2. Indicate sizes and elevations of piping, conduit, and penetrations.
- D. Manufacturer's Certificate: Certify that products meet or exceed the Specifications.
- E. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.
- F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three (3) years' documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. [Section 01 60 00 - Product Requirements](#): Requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Comply with precast concrete manufacturer's instructions and ASTM C913 for unloading, storing, and moving precast manholes and drainage structures.
- D. Storage:
1. Store precast concrete manholes and drainage structures to prevent damage to Owner's property or other public or private property.
 2. Repair property damaged from materials storage.

PART 2 - PRODUCTS

2.1 MANHOLES AND STRUCTURES

- A. Manufacturers:
1. Oldcastle Precast, Inc.
 2. Jensen Precast
 3. Cook Concrete Products, Inc.
 4. US Concrete Precast Group
 5. Forterra
 6. Or approved equal

- B. Manhole and Structure Sections:
 - 1. Description: Reinforced precast concrete conforming to ASTM C478 with gaskets conforming to ASTM C923.
 - 2. Joints for Precast Manholes and Structures:
 - a. Conforming to ASTM C913.
 - b. Maximum Leakage: 0.025 gal. per hour per foot of joint at 3 feet of head.
- C. Manhole and Structure Sections: Reinforced cast-in-place concrete as specified in [Section 03 30 00 – Utility Cast-in-Place Concrete](#).
- D. Mortar and Grout:
 - 1. Type S with minimum 28-day compressive strength of 2,100 psi.
- E. Reinforcement: Formed steel: Welded wire and reinforcing rebar per ASTM A615 Grade 60.
- F. Shaft Construction and Eccentric Cone Top Section:
 - 1. Pipe Sections: Reinforced precast concrete, unless specified otherwise.
 - 2. Joints:
 - a. Watertight Joints
 - b. Dry.
 - 3. Sleeved to receive pipe.
- G. Shape: Cylindrical for Manholes and Square or Rectangular for inlet structures
- H. Clear Inside Dimensions: Diameter of Minimum 48 inches for manholes unless specified otherwise on the Drawings.
- I. Design Depth: As indicated on Drawings.
- J. Clear Cover Opening: Diameter of Minimum 26 inches unless specified otherwise on the Drawings.
- K. Pipe Entry: Furnish openings as indicated on Drawings.
- L. Structure Joint Gaskets:
 - 1. ASTM C361.
 - 2. Material: Rubber.
- M. Steps: No steps are to be installed in any structures.

- N. All storm drain inlet structures require a fish decal with the wording, “No Dumping, Drains to Delta”, or as approved by the Project Manager.
- O. The exterior surfaces of all Precast Concrete Structure sections shall be waterproofed.
 - 1. Tremco, TREMproof 250GC
 - 2. Or approved equal.

2.2 FRAMES, GRATES AND COVERS

A. Manufacturers:

- 1. D&L Foundry and Supply
- 2. Neenah Enterprises, inc.
- 3. EJ
- 4. Or approved equal.

B. Description:

- 1. Construction: ASTM A48, Class 35B, AASHTO M306, cast iron.
- 2. Lid:
 - a. Machined flat bearing surface.
 - b. Lockable on all unpaved areas and Boltable for all grates.
 - c. One Pick/Lift hole
- 3. Grate: Grates shall be boltable and covers in unpaved areas shall be lockable.
- 4. Cover Design: Closed, Open checkerboard grille ASTM grid pattern and waterproof.
- 5. Frame and covers shall be non-rocking.
- 6. Wheel Load Rating: H-20.
- 7. Sealing gasket.
- 8. Cover: Molded with identifying name and logo: Storm Drain or Sanitary Sewer, City of Pittsburg.
- 9. Grate: Galvanized and Bicycle safe
- 10. All castings shall be thoroughly cleaned and subject to a hammer inspection after which they shall be twice dipped with an asphalt or coal tar coating applied at a temperature of not less than 290° F, nor more than 310° F.

2.3 RISER RINGS

A. Riser Rings:

- 1. 4 Inches to 6 Inches Thick:

- a. Material: Precast concrete.
 - b. Comply with ASTM C478.
2. Less than 4 Inches Thick:
- a. Material: Cast iron.
 - b. Comply with AASHTO M306.

B. Accessories:

- 1. Joint Sealant: Comply with ASTM C990.

2.4 RUBBER SEAL WRAPS:

- 1. Rubber Seal Wraps shall be
 - a. Wraps and Band Widths: Conform to ASTM C877, Type III.
 - b. Cone/Riser Ring Joint: Minimum 3 inches of overlap.
 - c. Frame/Riser Ring Joint: 2 inches of overlap.
 - d. Additional Bands: Overlap upper band by 2 inches.

2.5 CONCRETE CRADLES

A. Concrete Cradle:

- 1. As specified in Section 03 30 00 – Utility Cast-in-Place Concrete.
- 2. Description: Minimum compressive strength of 4,000 psi, 28-day reinforced concrete, air entrained, rough troweled finish.

B. Cast-in-place Concrete Reinforcement: As specified in Section 03 30 00 – Utility Cast-in-place Concrete.

2.6 MATERIALS

A. Bedding and Backfill:

- 1. Install minimum 8-inches thick Class 2 Permeable material as specified in Section 31 23 16 – Utility Trenching below the manholes and structures.
- 2. Bedding and Backfill shall conform to Section 31 23 16 – Utility Trenching.

2.7 ACCESSORIES

A. Foundation Slab:

1. Cast-in-place concrete as specified in Section 03 30 00 – Utility Cast-in-Place Concrete.
 2. Top Surface: Level.
- B. Interior Manhole Coating: Coatings shall be white in color or grey in color.
1. Manufacturers:
 - a. Sewper Coat
 - b. Carboline
 - c. Or approved equal.
- C. Concrete: As specified in [Section 03 30 00 – Utility Cast-in-Place Concrete](#)
- D. Grout: As specified by the Manufacturer.

2.8 FINISHES

- A. Steel Galvanizing:
1. ASTM A123.
 2. Hot dip galvanize after fabrication.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that items provided by other Sections of Work are properly sized and located.
- B. Verify that built-in items are in proper location and are ready for roughing into Work.
- C. Verify correct size of manhole and structure excavation.

3.2 PREPARATION

- A. [Section 01 70 00 - Execution](#): Requirements for installation preparation.
- B. Mark each precast structure by indentation or waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers as indicated on Drawings to indicate its intended use.
- C. Coordinate placement of inlet and outlet pipe or duct sleeves required by other Sections.

- D. Do not install manholes and structures where Site conditions induce loads exceeding structural capacity of manholes or structures.
- E. Inspect precast concrete manholes and structures immediately prior to placement in excavation to verify that they are internally clean and free from damage; remove and replace damaged units.

3.3 INSTALLATION

A. Excavation and Backfill:

1. Excavate for manholes and structures as specified in [Section 31 23 16 – Utility Trenching](#) and in indicated locations and depths.
2. Provide twenty-four (24) inches of minimum clearance around sidewalls of manhole or structure for construction operations, granular backfill, and placement of geotextile filter fabric if required.
3. If groundwater is encountered, prevent accumulation of water in excavations; place manhole or structure in dry trench. Where possibility exists of watertight manhole or structure becoming buoyant in flooded excavation, anchor manhole or structure to avoid flotation, as approved by Project Manager.

B. Foundation Slab:

1. Cast-in-place foundation slab and trowel top surface level. Precast foundation slabs are acceptable with approval from City.
2. Place manhole sections plumb and level, trim to correct elevations, and anchor to foundation slab.

C. Install manholes and structures supported at proper grade and alignment on Class 2 permeable material bedding extending twenty-four (24) inches beyond the sidewalls of manholes or structures.

D. Backfill excavations for manholes and structures as specified in [Section 31 23 16 – Utility Trenching](#)

E. Form and place manhole or structure cylinder plumb and level, to correct dimensions and elevations.

F. Cut and fit for pipe, conduit and sleeves.

G. Grout base of shaft sections to achieve slope to exit piping, trowel smooth, and contour to form continuous drainage channel as indicated on Drawings.

H. Paint interior with two coats of interior coating at rate of 120 sq. ft. per gal. for each coat.

- I. Set cover frames and covers level to correct elevations without tipping.
- J. Precast Concrete Manholes and Structures:
 1. Lift precast components at lifting points designated by manufacturer.
 2. When lowering manholes and structures into excavations and joining pipe to units, take precautions to ensure that interior of pipeline and structure remains clean.
 3. Set precast structures, bearing firmly and fully on Class 2 Permeable Material bedding, compacted as specified in [Section 31 23 16 – Utility Trenching](#) or on other support system as indicated on Drawings.
 4. Assembly:
 - a. Assemble multi-section manholes and structures by lowering each section into excavation.
 - b. Install rubber gasket joints between precast sections according to manufacturer's recommendations.
 - c. Lower, set level, and firmly position base section before placing additional sections.
 5. Remove foreign materials from joint surfaces and verify sealing materials are placed properly.
 6. Maintain alignment between sections by using guide devices affixed to lower section.
 7. Joint sealing materials should be installed on site.
 8. Verify that installed manholes and structures meet required alignment and grade.
 9. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe; fill annular spaces with mortar.
 10. Cut pipe flush with interior of structure.
 11. Install synthetic rubber water stop gasket at all pipe entries.
 12. Shape inverts through manhole and structures as indicated on Drawings.
- K. Cast-in-Place Concrete Manholes and Structures:
 1. Unless approved in writing by the City Engineer, Cast-in-Place Concrete Manholes shall only be constructed to retrofit existing sanitary sewer mains at locations without an existing manhole in place.
 2. Cast-in-Place Concrete Manholes shall be installed in accordance with Central San Standard Specifications for Design and Construction.
 3. Prepare Class 2 Permeable Material bedding or other support system as indicated on Drawings to receive base slab as specified for precast structures.

4. Erect and brace forms against movement, install reinforcing steel, place and cure concrete as specified in [Section 03 30 00 – Utility Cast-in-Place Concrete](#).

L. Sanitary Manhole Exterior Drop Connections:

1. CLSM Encasement: Minimum 2 feet outside of manhole.
2. Form channel from pipe drop to sweep into main channel at maximum angle of 30 degrees.

M. Castings:

1. Set frames using mortar and masonry as indicated on Drawings.

3.4 FIELD QUALITY CONTROL

- A. [Section 01 77 00 - Closeout Requirements](#): Requirements for testing, adjusting, and balancing.

- B. Test cast-in-place concrete as specified in [Section 03 30 00 – Utility Cast-in-Place Concrete](#).

- C. Test concrete manhole and structure sections prior to backfill according to ASTM C497 as specified in [Section 33 01 30 - Testing for Sanitary Sewer, Storm Drainage - Piping and Manholes](#).

D. Vertical Adjustment of Existing Manholes and Structures:

1. If required, adjust top elevation of existing manholes and structures to finished grades as indicated on Drawings.
2. Frames, Grates, and Covers:
 - a. Install a false bottom to prevent dirt getting into the structure. Carefully remove frames, grates, and covers cleaned of mortar fragments.
 - b. Reset to required elevation according to requirements specified for installation of castings.

3. Reinforcing Bars:

- a. Remove concrete without damaging existing vertical reinforcing bars if removal of existing concrete wall is required.
 - b. Clean vertical bars of concrete and bend into new concrete top slab or splice to required vertical reinforcement as indicated on Drawings.
4. Clean and apply sand-cement bonding compound on existing concrete surfaces to receive cast-in-place concrete as specified in [Section 03 30 00 – Utility Cast-in-Place Concrete](#).

3.5 REHABILITATION OF MANHOLES

- A. Contractor shall hire a certified Manhole Rehabilitation Inspector by NASSCO (National Association of Sewer Service Companies).
- B. Remove existing steps within manhole.
- C. Clean and prepare interior surface of manhole using a power wash with up to 5000 psi to remove all loose concrete to get to a good substrate.
- D. Repair any existing leaks considered as weepers using a fast setting blend of special cements and fillers that is used to stop leaks through cracks and holes on underground concrete and brick structures and remove any infiltrating roots. Manufacturer for fast setting blend of cement shall be Mainstay ML-10 or approved equal.
- E. Apply up to 3/4" of a Portland cement-based, microsilica-enhanced, high-strength structural restoration and resurfacing mortar designed to be applied at a minimum of 1/4", and up to 5" on vertical and overhead surfaces and trowel it to get a smooth finish. Manufacturers for Portland cement-based resurfacing mortar is Mainstay ML-72 or approved equal.
- F. Spray 100 mils of a 100% solids epoxy coating. Manufacturer is Mainstay DS-5, or approved equal.
- G. Finalize with at least 4" wide of a 100% solids flexible epoxy joint sealant that is applied by trowel to the joint between the chimney and the manhole frame, at a thickness of 1/4" to prevent premature cracks where the manhole frame and mortar meet. Manufacturer for this flexible epoxy joint sealant is Madewell 806, or approved equal.
- H. Create a smooth transition between the bench and the walls of the manhole to avoid debris accumulation.
- I. Seal, plug, patch and coat the manhole structure as specified in the specifications from bench up to the top of each manhole.
- J. Contractor shall provide a minimum one year guarantee of material from the manufacture company and one year on workmanship.

END OF SECTION 33 05 13

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SECTION 33 05 17 - PRECAST CONCRETE VALVE VAULTS AND METER BOXES**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Precast concrete valve vaults.
2. Precast concrete meter boxes.

B. Related Requirements:

1. [Section 33 11 13 - Water Distribution Piping](#): Execution requirements for piping Work as required by this Section.

1.2 UNIT PRICE - MEASUREMENT AND PAYMENT

A. [Section 01 29 00 - Payment Procedures](#): Contract Sum/Price modification procedures.

B. Precast Concrete Valve Vaults:

1. Basis of Measurement: By each.
2. Basis of Payment: Includes sawcut, demolition, excavation, all utility trenching work as specified in Section 31 23 16 – Utility Trenching, protecting the excavation in compliance with Cal/OSHA, installing valve vault, accessories, tests, backfill and surface restoration.

C. Precast Concrete WATER Meter Boxes:

1. Basis of Measurement: By each.
2. Basis of Payment: Includes sawcut, demolition, excavation, water meter box, accessories, test, and backfill and surface restoration.

1.3 REFERENCE STANDARDS

A. ASTM International:

1. ASTM A48 - Standard Specification for Gray Iron Castings.
2. ASTM A185 - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
3. ASTM A536 - Standard Specification for Ductile Iron Castings.
4. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.

5. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
6. ASTM C33 - Standard Specification for Concrete Aggregates.
7. ASTM C150 - Standard Specification for Portland Cement.
8. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
9. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
10. ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
11. ASTM C890 - Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.
12. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.
13. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
14. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft³ (600 kN-m/m³)).
15. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
16. ASTM D4104 - Standard Test Method (Analytical Procedure) for Determining Transmissivity of Nonleaky Confined Aquifers by Overdamped Well Response to Instantaneous Change in Head (Slug Tests).
17. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.4 COORDINATION

- A. Coordinate Work with other utilities within construction area.

1.5 SUBMITTALS

- A. [Section 01 33 00 - Submittal Procedures](#): Requirements for submittals.
- B. Product Data: Submit data on valve vaults and meter boxes.
- C. Shop Drawings: Indicate plan, location, and inverts of connecting piping.
- D. Manufacturer's Certificate: Certify that precast concrete valve vaults and meter boxes meet or exceed ASTM standards and specified requirements.

- E. Manufacturer Instructions: Submit special procedures for precast concrete valve vaults and meter boxes installation.
- F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- G. Qualifications Statement:
 - 1. Submit qualifications for manufacturer.

1.6 CLOSEOUT SUBMITTALS

- A. [Section 01 78 00 - Closeout Submittals](#): Requirements for closeout procedures.
- B. Project Record Documents: Record actual locations and inverts of buried pipe, components, and connections.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. [Section 01 60 00 - Product Requirements](#): Requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Transport and handle precast concrete units with equipment designed to protect units from damage.
- D. Storage:
 - 1. Store precast concrete valve vaults and meter boxes according to manufacturer instructions.
 - 2. Do not place concrete units in position to cause overstress, warping, or twisting.

PART 2 - PRODUCTS

2.1 DESIGN REQUIREMENTS

- A. Performance and Design Criteria:
 - 1. Watertight, Precast, Reinforced, Air-Entrained Concrete Structures:
 - a. Design to ASTM C890 A16: equivalent to AASHTO HS20 - 16-kip wheel live loading and installation conditions.

- b. Manufactured to conform to ASTM C913.
2. Minimum 28-Day Compressive Strength: 5,000 psi
3. Honeycombed or re-tempered concrete is not permitted.

2.2 WATER METER BOXES

A. Manufacturers:

1. Christy
 - a. B9X with FL9X lid for $\frac{3}{4}$ " meter
 - b. B16 with FL16D lid for 1-inch meters.
 - c. B-36 (17 $\frac{1}{4}$ " X30") with FL36E lid for 1 $\frac{1}{2}$ " & 2" meter
 - d. R37 P36 Pit with R37-52HT lid for 3" thru 6" meters
 - e. For 4" meter and larger, install concrete water meter vaults. Submit detailed drawings.
 2. Or approved equal
- B. After payment of fees, water meter shall be furnished and installed by the city for new services.
- C. When meter box is to be located in an area subject to vehicular traffic loading, the permittee shall furnish a regular box for $\frac{3}{4}$ " & 1" meters and a H/20 traffic rated box for 1 $\frac{1}{2}$ " & 2" meters. Traffic box cover shall be FL12 box with FL12D lid for $\frac{5}{8}$ " x $\frac{3}{4}$ " through 1-inch meters (or approved equal) and Christy B10" X 17" with B36-616 lid (or approved equal) for 1 $\frac{1}{2}$ " & 2" meters.
- D. For all types of pipes, service saddle shall be Mueller H-13000 series cc tapered thread (or approved equal). Saddles for PVC pipe shall be double or wide strap design.
- E. Corporation stop shall be 1" Mueller B-25008N (or approved equal) for $\frac{3}{4}$ " & 1" meters and a 2" Mueller B-25008N (or approved equal) for 1 $\frac{1}{2}$ " & 2" meters.
- F. Angle meter stop shall be Mueller B-24258N (or approved equal) for $\frac{3}{4}$ " & 1" meters and a 2" Mueller B-24276N (or approved equal) for 1 $\frac{1}{2}$ " & 2" meters.
- G. Water meter shall be located in the center of water meter box.
- H. Water lateral and services to be sized per the requirements of latest version of the California plumbing code.
- I. All water service fittings shall be lead-free
- J. Where the material for service fittings is specified to be bronze, brass fittings may be used.

- K. Minimum cover over building supply (yard piping) shall not be less than that specified in the plumbing code.
- L. 1" x 3/4" brass reducer shall be used for 5/8" x 3/4" meter.
- M. The meter box for a 1 1/2" turbine meter shall be a Christy B-30E lid (or B-30-61G for traffic areas), or approved equals. The meter box for a 2 in turbine shall be a Christy B-36 box with B-36E lid (or B-36-61G for traffic areas), or approved equals.
- N. 5lb minimum anode required on all copper service lines 2" and smaller unless geotechnical report stipulates, it is not necessary. Additional weight may be required by geotechnical report. Insulating coupling required between copper water lateral and water if main is metallic.
- O. Meter boxes, extensions, and covers shall be commercial products. Boxes shall be large enough to allow easy maintenance, testing, and removal meters.

2.3 PRECAST CONCRETE VALVES

- A. Manufacturers:
 - 1. Oldcastle Precast, Inc.
 - 2. Jensen Precast
 - 3. Or approved equal
- B. Valve Vault and Covers:
 - 1. Cast Iron Castings:
 - a. ASTM A48, Class 30 or better.
 - b. Free of bubbles, sand, air holes, and other imperfections.
 - c. Slip resistant coating.
 - d. ADA rated grating in pedestrian routes and pathways.
 - 2. Christy G5 traffic valve box (or approved equal)

2.4 MATERIALS

- A. Portland Cement:
 - 1. ASTM C150, Type II.
- B. Coarse Aggregates:
 - 1. ASTM C33.
 - 2. Graded 1 inch to No. 4 sieve.
- C. Sand:

1. ASTM C33.
2. Fineness Modulus: 2.35.

D. Water:

1. Potable.
2. Clean and free of injurious amounts of acids, alkalis, salts, organic materials, and substances incompatible with concrete or steel.

E. Air-Entraining Admixtures: ASTM C260.

F. Reinforcing Steel:

1. Deformed Bars: ASTM A615, Grade 60.
2. Welded Wire Fabric: ASTM A185.

G. Joint Sealant:

1. ASTM C990.

H. Bedding and Backfill:

1. Bedding: Bedding Type, as specified in [Section 31 23 16 – Utility Trenching](#).
2. Backfill: Backfill Type, as specified in [Section 31 23 16 – Utility Trenching](#).

2.5 FABRICATION

- A. Fabricate precast reinforced concrete structures according to ASTM C913, to dimensions indicated on Drawings, and to specified design criteria.

2.6 MIXES

- A. Design concrete mix to produce required concrete strength, air-entrainment, watertight properties, and loading requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that piping connections, sizes, locations, and inverts are as indicated on Drawings.

3.2 PREPARATION

- A. [Section 01 70 00 - Execution](#): Requirements for installation preparation.
- B. Ream pipe ends and remove burrs.
- C. Remove scale and dirt from components before assembly.
- D. Establish invert elevations for each component in system.
- E. Hand trim excavation to suit valve vaults and meter boxes; remove stones, roots, and other obstructions.

3.3 INSTALLATION

- A. Bedding and Backfill:
 - 1. Excavate as specified in [Section 31 23 16 – Utility Trenching](#) for Work of this Section.
 - 2. Hand trim excavation for accurate placement of vaults and meter boxes to elevations indicated.
 - 3. Place bedding material level in one continuous layer and compacted depth and compact to percent maximum density as specified in [Section 31 23 16 – Utility Trenching](#).
 - 4. Backfill around sides of vaults and meter boxes, tamp in place, and compact to 95 percent maximum density.
 - 5. Maintain optimum moisture content of bedding material to attain required compaction density.
 - 6. Install vaults and meter boxes and related components on bedding.
- B. Connect piping.

3.4 FIELD QUALITY CONTROL

- A. [Section 01 77 00 - Closeout Requirements](#): Requirements for testing, adjusting, and balancing.
- B. Request inspection by Project Manager prior to placing aggregate cover over piping.
- C. Compaction Testing: Conform to ASTM D1557.
- D. When tests indicate Work does not meet specified requirements, remove Work, replace, and retest.

END OF SECTION 33 05 17

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SECTION 33 05 26 - UTILITY IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall provide all materials, equipment, and labor necessary to furnish, install all utility identifications systems and appurtenances as required and as specified below:
1. Pipeline marker posts.
 2. Metal utility markers.
 3. Marking flags.
 4. Plastic warning tape for placement above direct-buried utility.
 5. Trace wire for placement above direct-buried utility.
- B. Related Requirements:
1. [Section 31 23 16 - Utility Trenching](#): Backfilling considerations for installation of underground pipe markers.
 2. [Section 33 11 13 - Water Distribution Piping](#): Piping, valves, and appurtenances requiring identification marking.
 3. [Section 33 31 13 - Sanitary Sewer Piping](#): Piping, valves, and appurtenances requiring identification marking.
 4. [Section 33 41 13 - Storm Drainage Piping](#): Piping, valves, and appurtenances requiring identification marking.

1.2 SUBMITTALS

- A. [Section 01 33 00 - Submittal Procedures](#): Requirements for submittals.
- B. Product Data: Submit manufacturer's catalog information for each product required.
- C. Samples: Submit one sample of pipeline marker post, utility marker, marking flag, 10 feet of warning tape, and 10 feet of trace wire.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Qualifications Statement: Submit qualifications for manufacturer.

1.3 CLOSEOUT SUBMITTALS

- A. [Section 01 78 00 - Closeout Submittals](#): Requirements for submittals.
- B. Project Record Documents: Record actual locations of tagged valves.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. [Section 01 77 00 - Closeout Requirements](#): Requirements for maintenance materials.

PART 2 - PRODUCTS

2.1 PIPELINE MARKER POSTS

- A. Manufacturers:
 - 1. Furnish above ground utility marker materials with visibility enhancer according to City standards.
 - a. Pro-Mark Utility Supply Inc,
 - b. Northtown Company
 - c. Bernsten
 - d. or approved equal.
- B. Description:
 - 1. Material: High Impact Fiberglass Reinforced Resins
 - 2. Width: 4 inches +/- 0.25 inches
 - 3. Length: 96 inches
 - 4. Color: Orange (Telecommunications, Fiber Optic cables or conduits), Yellow (Natural Gas, Oil, Steam, Petroleum Pipelines), Blue (Water lines), Red (Electric Power Lines, cables), Green (Sewer and Drain Lines), Purple (Reclaimed Water, Irrigation), White (Proposed excavation limits) and Pink (Temporary Survey Markings, Unknown/Unidentified facilities).
 - 5. Embedment: T-anchor.
 - 6. Technical Data:

Description	Test Spec. or Criteria	Test Result
Tensile Strength	ASTM D638	410 kg/cm ²
Tensile Elongation	ASTM D638	35%
Tensile Modulus	ASTM D638	17,600 kg/cm ²
Flexural Strength	ASTM D790	660 kg/cm ²
Flexural Modulus	ASTM D790	19,500 kg/cm ²
IZOD Impact Strength	ASTM D256	45 kg cm/cm
Heat Deflection Temp	ASTM D648	204.8°F

Vicat Softening Temp	ASTM D1525	201.2°F
Flammability	UL94	HB Class

2.2 UTILITY MARKERS

A. Manufacturers:

1. Furnish materials according to City standards.
 - a. Bernsten
 - b. Rhino
 - c. or approved equal.

B. Metal:

1. Material: Bronze
2. Diameter: 2 inches.
3. Stem: 3/4 by 2 inches
4. Text: "Warning Water Pipeline Caution Call 811 Before you dig" or "Stub for Pipeline".

2.3 MARKING FLAGS

A. Manufacturers:

1. Furnish materials according to City standards.
 - a. Bernsten
 - b. Presco Products
 - c. or approved equal.

B. Description:

1. Material: Polyethylene
2. Minimum Size: 2-1/2 by 3-1/2 inches.
3. Wire Stem: 21 inches
4. Color: Yellow, Orange, Blue, Green, Red, Pink and White.
5. Text: Blue (Buried Waterline), Red (Buried Electric Line), Pink (Survey Marker), Green (Buried Sewerline), Yellow (Buried Gas line) and Orange (Buried Fiber Optic conduits).

2.4 WARNING TAPE

A. Warning Tape:

1. Warning Tape shall be installed on all pipes greater than 2 inches and the warning tape shall be placed above the centerline of the pipe, spanning the full length of the pipe, and be placed at a depth of 1-foot above top of pipe.
2. Furnish materials according to National Transportation Safety Board NTSB-PSS-73-1, GSA Public Buildings Service Guide, American Gas Association

72-D-56, API RP 1109, OSHA 1926.956 (c)(1), APWA Uniform Color Code, DOT Office of Pipeline Safety USAS B31.8, and Federal Gas Safety Regulations S 192-321 (e).

3. Technical Data:

Properties	Test Method	Value
Thickness	ASTM D2103	0.005" (5 mil)
Elongation	ASTM D882-75B	80%
Colors	APWA Coded	See below
Tensile Strength	ASTM D882	35 lbs/inch (15,000 psi)
Bond Strength	Boiling Water	5 Hours w/o Peel
Adhesives	Mfg. Specs	Morton 548 or Equivalent
Bottom Later	Mfg. Specs	Virgin PE
Top Later	Mfg. Specs	Virgin PET
Foil	Mfg. Specs	0.00035 (0.35 Mil)
Flexibility	ASTM 671-76	Pliable Hand
Message Repeat	Mfg. Specs	AXL II
Inks	Mfg. Specs	Varies per Legend
Printability	ASTM D2578	45 Dynes

- 4. Manufacturers:
 - a. Northtown Company
 - b. Christy's
 - c. Bernsten
 - d. or approved equal.

B. Description:

- 1. Material: Polyethylene
- 2. Brightly colored, continuously printed.
- 3. Minimum Size: 6 inches wide by 5 mils thick.
- 4. Manufactured for direct burial service.
- 5. Lettering Size: 1 inch
- 6. Color: All tape is APWA color coded and permanently printed
 - a. Red – Electric, Fire
 - b. Yellow – Gas, Oil
 - c. Blue – Water, Potable Water
 - d. Green – Sewer, Storm Drain
 - e. Orange – Fiber Optic, Telephone
 - f. Purple – Recycled Water, Non-Potable Water.
- 7. Standard Imprints: "CAUTION WATER LINE BURIED BELOW", "CAUTION SEWER LINE BURIED BELOW", "CAUTION SANITARY SEWER BURIED BELOW", "CAUTION GAS LINE BURIED BELOW", "CAUTION HIGH VOLTAGE ELECTRIC BURIED BELOW" or other custom utility legends in large letters.

2.5 TRACE WIRE

A. Tracer Wire:

1. Tracer wire shall be used on all pressure piping (water, recycled water, irrigation water, sewer force main etc). Tracer wire shall be blue and suitable for direct burial and wet conditions.
2. Tracer wire shall be continuous and splices shall be made with two copper or brass split bolt fasteners without encapsulation in epoxy.
3. Contractor shall submit proof of continuity testing to the City in a written format.
4. Tracing wire through valve boxes shall be placed outside of riser but inside the valve box.
5. Tracer wire shall be UL listed, Standard 83, conforming to Federal Specification JC-30-B, ANSI-C 33.80 and the requirements of National Electric Code.
6. For all pressure piping systems (potable, recycled water, sewer force mains, irrigation system, and water valves), a No. 12 A.W.G. UF Insulated solid copper wire shall be attached to the pipeline.
7. The wire shall be taped to hold in place and the tape shall be 2 inches wide, 10 mil. thick. On mains the wire shall be held in place with tape spaced not more than 10 feet apart. On service laterals the wires shall be wrapped around the pipe.
8. Furnish materials according to City standards.
 - a. Northtown Company
 - b. Priority Wire and Cable, Inc.
 - c. or approved equal.
9. Description:
 - a. Wire: Unshielded 12-AWG THWN insulated copper.

2.6 RECYCLED WATER SIGNING

- A. Contractor shall provide all identification signs and stickers for irrigation controllers for recycled water systems in compliance with Delta Diablo Water District's requirements.
- B. Signs shall be measured no less than 8"x8" with white type against a purple background.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Pipeline Marker Posts, Utility Markers, and Marking Flags: As recommended by manufacturer.
- B. Warning Tape and Tracer Wire:

1. Warning tape shall be continuous over top of pipe buried 12 inches above piping.
2. Tracer wire shall be taped to the pipe.
3. If multiple pipes occur in common trench, locate tape and wire above centerline of trench.
4. Coordinate with trench Work as specified in [Section 31 23 16 – Utility Trenching](#).

END OF SECTION 33 05 26

SECTION 33 05 63
PRECAST CONCRETE UTILITY STRUCTURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Precast concrete manholes, catch basins and utility vaults.
- B. Manhole, catch basin and utility vault frames and covers.

1.2 REFERENCED SECTIONS

- A. The following Sections are referenced in this Section
 - 1. Section 08385 – Aluminum Utility Vault Doors
 - 2. Section 08386 – Steel Utility Vault Doors
 - 3. Section 40 80 01 – Testing Gravity Flow Pipelines

1.3 SUBMITTALS

- A. Product Data:
 - 1. Manhole barrels, bases, cones, grade rings, tops, frames, and covers.
 - 2. Rubber boot-type pipe connectors for connecting piping to manholes.
 - 3. Catch basin sections, basins, tops, frames, and grates
 - 4. Utility vault access hatches.
 - 5. Accessories for utility vaults.
- B. Utility Structure Details:
 - 1. Manufacturer's standard shop drawings for each size and type of precast utility structure.
 - a. Provide dimensions of structure.
 - b. Identify location of each type of insert cast into the structure.
 - 2. Illustrate construction details related to joints between precast sections, method of connecting pipe to the structure, size and location of pipe penetrations, reinforcement details and concrete mix design.
- C. Structural Design:
 - 1. Laboratory results verifying compressive strength of concrete mix design used in the manufacture of precast concrete utility structures.
 - 2. Calculations and related sketches prepared, stamped and signed by a civil or structural Professional Engineer licensed to practice in the state of California.

1.4 DESIGN REQUIREMENTS

- A. Concrete Mix Design for products covered by this Section:
 - 1. Minimum Compressive Strength: 4,000 psi at 28 days.
 - 2. Cement: Type II low alkali Portland cement meeting requirements of ASTM C150.
 - 3. Fly Ash: Class C or Class F meeting requirements of ASTM C618, not to exceed 25 percent by weight.

4. Aggregates: Conform to requirements of ASTM C33.
- B. Manhole Risers, Conical Tapered Sections, Grade Rings and Flat Top Sections: Comply with design requirements specified in ASTM C478.
- C. Catch Basins:
 1. Conform to ASTM C858.
 2. Base design and manufacture to A-16 (HS 20-44) loading in accordance with ASTM C857.
- D. Utility Vaults:
 1. Base design and manufacture to A-16 (HS 20-44) loading with 30 percent impact in accordance with ASTM C857.
 2. Traffic Loads:
 - a. Utility Vaults in Roadways: H-20 structural load rating according to AASHTO HB 17.
 - b. Utility Vaults in Driveways, Parking Lots and other Off-Roadway Locations: H-10 structural load rating according to AASHTO HB 17.
 3. Earth Loads: Design for lateral earth pressure of 85 pounds per cubic foot and equivalent fluid pressure of 60 pounds per cubic foot applied at a depth of 1/3 H below the ground surface where H is the height of the utility vault.
 4. Seismic Loads: Design in accordance with the requirements of the [cite equivalent California code and seismic zone].
 5. Buoyancy: Select wall and slab thicknesses to provide sufficient weight against buoyancy due to groundwater elevations.
 - a. Consider groundwater elevation at the ground surface.
 - b. Utilize a safety factor of 1.1.
 - c. Do not take credit for friction forces that may develop between the soil backfill and concrete walls of the utility vault.
 6. Access Hatch and Lid Loading Criteria:
 - a. Access hatches and vault lids subject to wheel loads from vehicular traffic: H-20 structural load rating according to AASHTO HB 17.
 - b. Access hatches and vault lids not subject to wheel loads from vehicular traffic: 200 pounds per square foot with a deflection not to exceed 1/150 of the span.

1.5 COORDINATION

- A. Coordinate layout and installation of utility structures with the final arrangement of other utilities, site grading, and surface features as determined in the field.

PART 2 - PRODUCTS

2.1 PRECAST CONCRETE MANHOLES

- A. Conform to the requirements of ASTM C478.
- B. Construct precast reinforced concrete manholes in accordance with design, size, shape, form and details indicated on the Drawings and specified.
 1. Minimum Diameter: 48 inches.

- C. Conical Tapered Sections: Use eccentric type cones with same wall thickness and reinforcement as riser sections.
- D. Accessories:
 - 1. Rubber Boot Pipe Connectors:
 - a. Manufacturers: One of the following or equal:
 - 1) "Kor-N-Seal" flexible rubber boot with stainless steel accessories as manufactured by NPC, Inc.
 - 2) "Z-LOK XP" or "A-LOK" flexible connector as manufactured by A-LOK Products, Inc.
 - 2. Joint Sealing Compound: Preformed cold-applied ready-to-use plastic joint sealing compound.
 - a. Manufacturers: One of the following or equal:
 - 1) Quikset Utility Vaults, Quik-Seal.
 - 2) K. T. Snyder Company, Ram-Neck.
 - 3. Manhole Frame and Cover Sets:
 - a. Cast Iron: ASTM A48, Class 30B.
 - b. Type, size, and features as indicated on the Drawings.
 - c. Grind mating surfaces of cover and frame to ensure flat, true fit and even seating.

2.2 PRECAST CONCRETE CATCH BASINS

- A. Provide precast concrete catch basins, drop inlets, curb inlets or other storm drain inlets as indicated on the Drawings.
- B. Manufacturers: One of the following or equal:
 - 1. Oldcastle Precast
 - 2. Christy Concrete Products.
- C. Description:
 - 1. Factory-fabricated, reinforced concrete box with frame and grate.
 - 2. Open or integral closed bottom as indicated on the Drawings or as scheduled.
 - 3. Monolithically poured walls and bottom, unless open-bottom vaults are indicated on the Drawings or scheduled.
- D. Materials
 - 1. Concrete: 5,000 psi at 28 days
 - 2. Reinforcing steel: ASTM A615 grade 60
 - 3. Mesh: Welded wire fabric ASTM A185 grade 65
- E. Frame and Grate
 - 1. Cast iron or hot dipped galvanized.

2.3 PRECAST CONCRETE UTILITY VAULTS

- A. Manufacturers: One of the following or equal:
 - 1. Christy Concrete Products.
 - 2. Utility Concrete Products, LLC.

3. Utility Vault Company.
- B. Description:
 1. Factory-fabricated, reinforced concrete vault with cover and accessories.
 2. Open or integral closed bottom as indicated on the Drawings or as scheduled.
 3. Monolithically poured walls and bottom, unless open-bottom vaults are indicated on the Drawings or scheduled.
- C. Frame and Cover:
 1. Unless access hatches are indicated or specified, fabricate steel frame and cover for utility vault openings.
 2. Frame: Galvanized steel or aluminum.
 3. Cover: Galvanized steel or aluminum with diamond pattern.
 4. Provide 1-inch diameter pick hole for each cover piece unless otherwise indicated.
 5. Split cover into pieces such that the maximum weight of each piece is less than 80 pounds.
- D. Access Hatches: Conform to Section 08385/08386.

PART 3 - EXECUTION

3.1 MANUFACTURE

- A. Utilize a central batching facility to ensure accurate weighing and mixing of materials to consistently obtain a suitable concrete mix.
- B. Concrete Batching: Properly proportion sand, aggregate and cement with sufficient water to produce a concrete mix of uniform quality and slump.
- C. Concrete Compaction: Use either external or internal mechanical vibration during placement of the concrete mix within the forms.
- D. Curing: Steam cure concrete while still in the forms and after an initial set has taken place.
 1. Steam temperature: Not to exceed 160 degrees F, nor raised from normal ambient temperature at a rate exceeding 40 degrees F per hour.
 2. Terminate steam curing after sufficient time has elapsed to produce adequate strength to withstand any structural strain that may occur during the form stripping operation.
 3. Additional curing may be applied by means of water spraying or membrane curing compound to reach the ultimate strength requirements.
- E. Reinforcing Steel: Position within the forms as required for design loads. Tie reinforcing steel sufficiently to withstand displacement during the pouring operation.

3.2 INSTALLATION

- A. Concrete Manholes:
 1. Manhole Bases: May be pre-cast or cast-in-place at Contractor's option. If cast-in-place base is used:
 - a. Form that portion of base above invert elevation of sewer pipe to provide smooth channel section as indicated on the Drawings.
 - b. Place base concrete as a monolith.

2. Manhole Invert: Construct with smooth transitions to provide an unobstructed flow path through the manhole. Remove sharp edges and rough sections.
 - a. When a full section of pipe is laid through the manhole, break out the top portion of the pipe. Cover the exposed edge of pipe with mortar and trowel smooth.
 3. Manhole Sections:
 - a. Set each manhole section plumb.
 - b. Use sections of various heights and adjustment rings in order to bring top of manhole ring and cover to required elevation.
 4. Joints in Manhole Sections:
 - a. Seal joints with joint sealing compound.
 - b. Clean joints with brush, prime and apply sealing compound in accordance with manufacture's printed instructions.
 - c. Remove silicon treated protective paper from one side of preformed rope and lay preformed rope, paper side up, on cleaned joint surface. Press surface firmly end-to-end around entire joint, making minimum 1-inch laps where necessary. Remove protective paper from preformed rope and lower next section into place.
 - d. Seal joints watertight.
- B. Manhole Frame and Cover Sets:
1. Location and Grade:
 - a. In Paved Areas: Set cover flush with pavement ± 0.25 inch
 - b. In Open Areas: Set cover above surrounding grade in accordance with the details indicated on the Drawings ± 1 inch
 - c. In existing roadside ditches or unpaved, untraveled right-of-way: Set cover approximately 12 inches above existing ground surface ± 2 inches
 2. Setting Frames:
 - a. Clean bearing surfaces and provide uniform contact.
 - b. Set manhole frames at required grade and securely attach to top of precast manhole shaft unit or on adjustment rings, using cement mortar.
 3. Setting Covers: After frames are securely set in place, install covers and perform necessary cleaning and scraping of foreign materials from frames and covers as necessary to assure proper fit. Replace frames and covers that create noise when passed over by traffic.
- C. Catch Basins:
1. Install catch basins level and plumb and with orientation and depth coordinated with connecting pipes.
 2. Support catch basin on a level bed of aggregate base material, 6 inches deep and compacted to 95 percent of maximum density.
 3. Seal joints with joint sealing compound. Clean joints and apply sealing compound in accordance with the manufacturer's requirements.
 4. Finish Elevations of Catch Basins
 - a. Paved Areas, Roadway Shoulders and Other Areas of Vehicular Traffic: Set structure so that cover is flush with finished pavement elevation ± 0.25 inch.
 - b. Other Locations: Set catch basin flush with finished grade ± 1 inch

5. Covers: install covers and perform necessary cleaning and scraping of foreign materials from frames and covers as necessary to assure proper fit. Replace frames and covers that create noise when passed over by traffic.
 - 6.
- D. Utility Vaults:
1. Comply with ASTM C891.
 2. When vaults are provided in sections, install vault sections level and plumb and with orientation and depth coordinated with connecting pipes.
 3. Support vault on a level bed of aggregate base material, 12 inches deep and compacted to 95 percent of maximum density.
 4. Seal joints with joint sealing compound. Clean joints and apply sealing compound in accordance with the manufacturer's requirements.
 5. Covers:
 - a. Install access hatches per Section 08385/08386.
 - b. Install covers and perform necessary cleaning and scraping of foreign materials from frames and covers as necessary to assure proper fit. Replace frames and covers that create noise when passed over by traffic.
 6. Finish Elevations of Utility Vaults
 - a. Paved Areas, Roadway Shoulders and Other Areas of Vehicular Traffic: Set structure so that cover is flush with finished pavement elevation ± 0.25 inch
 - b. Other Locations: Set utility vault so that cover is 4 inches above finished grade ± 1 inch

3.3 PIPE CONNECTIONS

- A. Install connecting pipe at the required alignment and grade.
- B. Set connecting pipes through the full thickness of the manhole wall, flush with the inner face of the wall.
- C. Use standard flexible pipe connector boots, specifically manufactured for the intended service, to connect pipe to the manhole. When concrete pipe is used, grout pipe to the manhole so that the connection is watertight.
- D. Plugging pipes provided for future connections:
 1. Pipe 18-inches or less in diameter; Plug with concrete, extend minimum 8 inches into pipe.
 2. Pipe greater than 18-inches in diameter: Construct plug using brick, concrete block or concrete, mortar exposed face of plugs constructed of brick and concrete block.

3.4 CLEANING

- A. Upon completion, clean each structure of all silt, debris, and foreign matter.

3.5 TESTING

- A. Test manholes for leakage in accordance with Section 40 80 01.

END OF SECTION

SECTION 33 13 00 - DISINFECTING OF WATER DISTRIBUTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Disinfection of potable water distribution and transmission systems.
2. Testing and reporting of results.

B. Related Requirements:

1. [Section 33 11 13 - Water Distribution Piping](#): Product and execution requirements for installation and testing of site domestic water distribution piping.

1.2 UNIT PRICE - MEASUREMENT AND PAYMENT

A. [Section 01 29 00 - Payment Procedures](#): Contract Sum/Price modification procedures.

B. Disinfection:

1. Basis of Measurement: Not a measured item.
2. Basis of Payment: Incidental to the price paid for linear foot of pipe and includes preparing, disinfecting, testing, and reporting.

1.3 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA B300 - Hypochlorites.
2. AWWA C651 - Disinfecting Water Mains (Please see section 1.6 QUALITY ASSURANCE A.1)

B. California Codes:

1. Titles 17 and 22 California Code of Regulations - Chapter 16 – California Waterworks Standards – Article 5. Disinfection Requirements - §64580 – Disinfection of New or Repaired Mains.
2. Titles 17 and 22 California Code of Regulations - Chapter 16 – California Waterworks Standards – Article 5. Disinfection Requirements - §64590 – Direct Additives.

1.4 SUBMITTALS

- A. [Section 01 33 00 - Submittal Procedures](#): Requirements for submittals.
- B. A testing schedule, include proposed plans for water conveyance, fill location, bleed location(s), control, disposal, and disinfection shall be submitted to the Project Manager for review a minimum of 72 hours before testing is to start.
- C. Submit plan for disinfection of pipelines, appurtenances, and any portion of the existing connecting system that might become contaminated during construction activities. The plan must outline how disinfection will be applied and implemented, the method used shall be the continuous feed method using sodium hypochlorite of no less than 12.0% strength, preventative and corrective measures to prevent contamination during construction, method of capping pipes, flushing plan, and bacteriological sampling plan. The plan must be in strict accordance with AWWA Standard C651-05. Other disinfection methods may be approved at the City's discretion.
- D. Product Data: Submit procedures, proposed chemicals, and treatment levels.
- E. Manufacturer's Certificate: Certify that products meet or exceed project requirements.
- F. Certify that cleanliness of water distribution system meets or exceeds the project requirements.
- G. Certify that water conforms or fails to conform to bacterial standards of the jurisdiction.
- H. Certify that water conforms to quality standards of the jurisdiction.
- I. Test and Evaluation Reports: Indicate testing results comparative to specified requirements.
- J. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- K. Qualifications Statements:
 - 1. Submit qualifications for water treatment firm and testing firm.

1.5 CLOSEOUT SUBMITTALS

- A. [Section 01 77 00 - Closeout Requirements](#): Requirements for submittals.
- B. Disinfection Report:

1. Type and form of disinfectant used.
2. Date and time of disinfectant injection start and time of completion.
3. Test locations.
4. Name of person collecting samples.
5. Initial and 24-hour disinfectant residuals in treated water in ppm for each outlet tested.
6. Date and time of flushing start and completion.
7. Disinfectant residual after flushing in ppm for each outlet tested.

C. Bacteriological Report:

1. Date issued, project name, and testing laboratory name, address, and telephone number.
2. Time and date of water sample collection.
3. Name of person collecting samples.
4. Test locations.
5. Initial and 24-hour disinfectant residuals in ppm for each outlet tested.
6. Coliform bacteria test results for each outlet tested.
7. Submit bacteriologist's signature and authority associated with testing.

1.6 QUALITY ASSURANCE

- A. Perform Work according to AWWA C651 with exception of the following:
1. The rest period for taking 1st and 2nd samples shall be 24 hours apart. (16-hour rest period is not an option!)

1.7 QUALIFICATIONS

- A. Water Treatment Firm: Company specializing in disinfecting potable water systems specified in this Section with minimum three (3) years' documented experience.

PART 2 - PRODUCTS

2.1 DISINFECTION CHEMICALS

A. Chemicals:

1. Hypochlorite: Comply with AWWA B300.
2. Chlorine for disinfection shall be in the form of sodium hypochlorite solution, or calcium hypochlorite granules or tablets.
3. The Contractor shall only use NSF approved chemicals in accordance with California Code of Regulations Title 22, Article 7. Section §64590.

4. The concentration dosage of chlorine for disinfecting water mains shall be as defined in AWWA Standard C651-05.

2.2 TEST EQUIPMENT

- A. All test equipment, temporary valves or assemblies, strainers, calibrated pressure gages, pumps, bulkheads, or other water control equipment and materials shall be furnished by the Contractor subject to the Project Manager's review. No materials shall be used which would be injurious to the piping system or its proposed function.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. [Section 01 70 00 - Execution](#): Requirements for installation examination.
- B. Verify that piping system has been cleaned, inspected, and pressure tested.
- C. Perform scheduling and disinfecting activity with startup, water pressure testing, adjusting and balancing, and demonstration procedures, including coordination with related systems.

3.2 INSTALLATION

- A. Provide and attach required equipment to perform Work of this Section.
- B. After completion of the hydrostatic test as specified in [Section 33 11 13 - Water Distribution Piping](#), the mains shall be thoroughly flushed with a minimum pipe velocity of 2.5 fps until the receiving water is free of visible dirt and impurities.
- C. Filling the system: Fill entire test system with the chlorine solution at a rate not to exceed 1 foot per second. Open all taps and valves and leave open until a strong odor of chlorine is noticeable in the water coming from the outlets, after which close the taps and valves. The chlorine residual must be verified by field sampling and be above 100 PPM at all points of the disinfected pipeline and at designated services.
- D. Testing Period: Allow chlorinated water to remain in the system a minimum of 24-hours, and then thoroughly flush the system. During retention period, operate all valves, stops, and other appurtenances to assist the disinfection process. After 24 hours, the minimum chlorine residual shall be verified by field sampling and not be less than 10 PPM at all points of the disinfected pipeline and at designated services.

- E. Post Disinfection Flushing: Flush, circulate, and clean until required cleanliness is achieved using municipal domestic water. Clean all pipelines by flushing with water or other means to remove all dirt, stones, pieces of wood, or other material which may have entered the pipes during the construction period. Debris cleaned from the lines shall be removed from the low end of the pipeline. If after this cleaning, obstructions remain, they shall be removed. Flush the potable water system to remove all super chlorinated water. Continue flushing until the receiving water is field verified and the chlorine residual is no higher than 3 PPM and is consistent with the City source water.
- F. Bacteriological Examination: After the system has been thoroughly flushed, the City requires that the new main and services test negative for total coliform and **Escherichia coli**. Two consecutive sets of samples and one sample from each dead end taken at least 24-hours apart every 600 feet shall be collected by the Contractor at locations approved by the City. At any time that a sample test positive, the disinfection process will restart from the beginning. The Contractor shall sample and perform bacteriological testing for the first two consecutive rounds of sampling, if the samples are all negative for total coliform and Escherichia coli. Contractor shall in writing notify the City 24-hours in advance of any sampling plan changes or results.
- G. Samples shall be taken no sooner than 24 hours after final flushing. Jumpers and/or plates shall be pulled within 14 days of the notification of a successful test, or new bacteria samples will have to be taken. Follow-up bacteriological testing shall take place after tie-ins have been made, and shall meet the same passing requirements as the initial tests.
- H. Should the initial disinfectant fail to produce satisfactory bacteriological test results, the disinfection procedure shall be repeated until acceptable results are obtained at the Contractor's cost if the first time fails (The first round of taking samples are free of charge). All lab costs for the bacteriological testing including staff hours (City of Pittsburg Master Fee Schedule) shall be borne by the Contractor. All costs for water used for flushing, and re-filling of the pipelines shall also be borne by the Contractor. The Contractor shall notify the City in writing a minimum of 7-days prior to commencing the disinfection of any pipe segment.
- I. Testing Documentation: In order to pass the disinfection process, the Contractor shall submit a written report verifying the initial chlorine dose of above 100 PPM, the chlorine residual after the 24-hour test period of above 10 PPM, and the chlorine residual for post disinfection flushing. The Contractor will be responsible for the bacteriological results for the two sets of consecutive samples. The Contractor shall be responsible for providing all required reports conducted in order to pass the disinfection process.

- J. Failure in following any portion of this section and American Water Works Standards C651-05, is in direct violation of the State of California Code of Regulations Article 5. Disinfection Requirements §64580. Disinfection of New or Repaired Mains.
- K. Disposal of Chlorinated Water: Dispose of chlorinated water in accordance with local agency, Delta Diablo Sanitation District (DDSD), state and federal regulations so that no water having chlorine residual reaches a surface stream. Contractor shall receive a permit from all above agencies including the City prior to any flushing operation.
- L. Final Flushing: After completion of successful disinfection process and connection to existing system, flush entire system to achieve velocities on the order of 3 feet per second. Continue flushing until water is free of dirt and impurities.
- M. After the pipelines are cleaned and if the groundwater level is above the pipe or following a heavy rain, the Project Manager will examine the pipes for leaks. If any further defective pipes or joints are discovered, the Contractor shall repair them. Finished paving shall not be installed prior to completion of all cleaning and testing.
- N. Replace permanent system devices that were removed for disinfection.
- O. After the samples have passed the bacteriological testing, the Contractor will be notified and arrangements can be made to make tie-ins and connections to house services

3.3 FIELD QUALITY CONTROL

- A. Section 01 77 00 - Closeout Requirements: Requirements for testing, adjusting, and balancing.
- B. Disinfection, Flushing, and Sampling:
 - 1. Disinfect pipeline installation according to AWWA C651.
 - 2. Use of liquid chlorine is not permitted.
 - 3. Taps for chlorination and sampling shall be installed by the Contractor.
 - 4. Upon completion of retention period required for disinfection, flush pipeline until chlorine concentration in water leaving pipeline is no higher than that generally prevailing in existing system or is acceptable for domestic use.
 - 5. Disposal:
 - a. Legally dispose of chlorinated water.
 - b. When chlorinated discharge may cause damage to environment, apply neutralizing chemical to chlorinated water to neutralize chlorine residual remaining in water.

- c. No discharge of chlorinated water to any storm sewer or natural water course will be allowed.
 - d. All costs for water disposal shall be borne by the Contractor.
6. After final flushing and before pipeline is connected to existing system or placed in service, employ an approved independent testing laboratory to sample, test, and certify that water quality meets quality standards of the jurisdiction.
7. Disinfection of tie-ins shall be performed by the Contractor by swabbing with chlorine or by other approved methods in the presence of Project Manager. Following a tie-in, the area affected by the tie-in shall be thoroughly flushed and bacteriological samples will be taken by the City as deemed necessary.

END OF SECTION 33 13 00

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SECTION 33 41 13 - STORM DRAINAGE PIPING**PART 1 - GENERAL**

1.1 SUMMARY

- A. This Section includes all materials, equipment, and labor necessary to furnish and install all storm drainage piping, piping accessories, drainage structures, bedding and cover materials, concrete encasement and cradles, and all appurtenant work, complete and operable, including all connections as shown on the Drawings and as specified herein.
- B. Related Requirements:
1. [Section 03 30 00 - Utility Cast-in-Place Concrete](#)
 2. [Section 03 60 00 - Grouting](#)
 3. [Section 31 05 13 - Clearing & Grubbing, Excavation, and Earthwork](#)
 4. [Section 31 23 16 - Utility Trenching](#)
 5. [Section 33 01 30 - Testing for Sanitary Sewer, Storm Drainage – Piping and Manholes](#)
 6. [Section 33 05 13 - Manholes and Structures](#)
 7. [Section 33 05 26 - Utility Identification](#)

1.2 UNIT PRICE - MEASUREMENT AND PAYMENT

- A. [Section 01 29 00 - Payment Procedures](#): Contract Sum/Price modification procedures.
- B. Pipe and Fittings:
1. Basis of Measurement: Storm Drainage Piping shall be measured by linear foot of pipe installed, measured from edge of structure to edge of structure for various pipe materials and various sizes irrespective of the depth of pipes.
 2. Basis of Payment: The contract price paid per linear foot for Storm Drainage piping shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in furnishing and installing Storm Drainage Piping, complete in place including bends, elbows or other pipe fittings, saw cut, excavating to required elevations, all utility trenching work as specified in [Section 31 23 16 – Utility Trenching](#), removing excavated materials, dewatering, bedding, cradles, backfill and backfill material, pipe installation with warning tape, restoration and disposing of materials outside the Right-of-Way and connections to existing or new storm drainage mains and manholes.

1.3 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:

1. AASHTO M170 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
2. AASHTO M206 - Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe.
3. AASHTO M207 - Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe.
4. AASHTO M 252 - Standard Specification for Corrugated Polyethylene Drainage Pipe 3"-10".
5. AASHTO M 294 - Standard Specification for Corrugated Polyethylene Pipe, 12"-60".

B. ASTM International:

1. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
2. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
3. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
4. ASTM C506 - Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe.
5. ASTM C969 - Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines.
6. ASTM C1103 - Standard Practice for Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines.
7. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
8. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
9. ASTM D1784 – Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
10. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
11. ASTM D2412 – Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
12. ASTM D2564 - Standard Specification for Solvent Cements for Polyvinyl Chloride (PVC) Plastic Piping Systems.
13. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.

14. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
15. ASTM D3212 – Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
16. ASTM D 3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
17. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
18. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
19. ASTM F679 – Standard Specification for Poly Vinyl Chloride (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
20. ASTM F2306 - Standard Specification for 12 to 60 in. Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications.
21. ASTM F2648 - Standard Specification for 2 to 60 in. Annular Corrugated Profile Wall Polyethylene (PE) Pipe and Fittings for Land Drainage Applications

1.4 SUBMITTALS

- A. [Section 01 33 00 - Submittal Procedures](#): Requirements for submittals.
- B. Product Data: Submit data indicating pipe, pipe accessories and gaskets
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

1.5 CLOSEOUT SUBMITTALS

- A. [Section 01 78 00 - Closeout Submittals](#): Requirements for submittals.
- B. Project Record Documents: Record actual locations of pipe installed and top of pipe elevations and invert of pipe at all structures.
- C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.
- D. As-built drawings shall be provided as part of the closeout submittals.

1.6 QUALITY ASSURANCE

- A. Perform Work according to City Standard Specification.
- B. Maintain one (1) copy of each standard affecting Work of this Section on Site.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three (3) years of documented experience.
- B. Installer: Company specializing in performing Work of this Section with minimum three (3) years of documented experience and approved by the Manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. [Section 01 60 00 - Product Requirements](#): Requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage. It is the responsibility of the Contractor to check quantities and note any missing or damaged items.
- C. Storage:
 - 1. Store materials according to manufacturer instructions.
 - 2. Block individual and stockpiled pipe lengths to prevent moving.
 - 3. Stack it on reasonably level ground.
 - 4. Do not place pipe or pipe materials on private property or in areas obstructing pedestrian or vehicle traffic.
 - 5. Do not place pipe flat on ground; cradle to prevent point stress.
 - 6. Don't stack the pipes next to heat sources such as boilers, steam lines, electrical equipment or engine exhausts.
 - 7. Gaskets should also be protected from heat, oil and grease.
- D. Protection:
 - 1. Keep UV-sensitive materials out of direct sunlight.
 - 2. Provide additional protection according to manufacturer instructions.

PART 2 - PRODUCTS

2.1 STORM DRAINAGE PIPING

- A. Reinforced Concrete Piping:

1. Pipe:
 - a. Comply with ASTM C76, AASHTO M170, ASTM C506, AASHTO M206, AASHTO M207, Class III or Class V, with Wall Type "B" or Wall "C" as specified in ASTM C76, however Wall "A" will not be allowed.
 - b. The minimum allowable class of RCP shall be class III for pipe cover from three (3) feet to fifteen (15) feet defined as the distance from the inside top of pipe to the top of finished grade. RCP pipe cover less than three (3) feet from finished grade shall be Class V. Pipe covers more than fifteen (15) feet deep shall require structural loading calculations.
 - c. Reinforcement: Circular reinforcing bars.
 - d. Inside Nominal Diameter: 12 inches through 144 inches
 - e. Ends: Bell and spigot.
 2. Fittings: Reinforced concrete.
 3. Joints:
 - a. Comply with ASTM C443.
 - b. Gaskets: O-Ring Rubber compression gaskets retained in a groove on the spigot end.
 4. Manufacturers:
 - a. Oldcastle Precast
 - b. Jensen Precast
 - c. Cook Concrete Products, Inc.
 - d. Or approved equal.
- B. Plastic Piping:
1. Pipe:
 - a. Material: PVC.
 - b. Comply with ASTM D3034, ASTM F79 - SDR 35 (Pipe Stiffness of 46psi) and SDR 26 (Pipe Stiffness of 115 psi)
 - c. PVC SDR-35 pipe shall be used for perforated pipes only.
 - d. The perforations shall be two rows of 1/2" diameter holes or openings at the bottom of the pipe 120° apart and five (5) inches on center.
 - e. Color: Green
 - f. Inside Nominal Diameter: Four (4) inches through Fifteen (15) inches per ASTM D3034 and Eighteen (18) inches through Forty-eight (48) inches per ASTM F679.
 - g. Style: Bell and spigot with rubber-ring sealed gasket joint.
 2. Fittings: PVC.
 3. Joints:
 - a. Comply with ASTM F477.

- b. Gaskets: Elastomeric.
- 4. Manufacturers:
 - a. JM Eagle
 - b. North American Pipe Corporation
 - c. Or approved equal
- C. Corrugated High Density Polyethylene Pipe (CHDPE):
 - 1. Pipe & Fittings:
 - a. Material: Corrugated PVC pipe with smooth interior must be manufactured from PVC virgin compounds, except clean, reworked, recycled PVC materials generated from the manufacturer’s pipe or fitting fabrication may be reused.
 - b. Corrugated PVC pipe and fabricated fittings shall be manufactured using High Density Polyethylene (HDPE) as defined and described in ASTM D3350 meeting the minimum requirements of cell classification of
 - 1) 424420C for 4”-10” pipe diameters and
 - 2) 435400C for 12”-60” pipe diameters, except the carbon black content should not exceed 4%.
 - c. Size:
 - 1) 4-inch through 10-inch: Comply with AASHTO M252, Type S and ASTM F2648
 - 2) 12-inch through 60-inch: Comply with AASHTO M294, Type S; ASTM F2306 and ASTM F2648
 - d. Manning’s n value: 0.012
 - e. Minimum pipe stiffness when tested under ASTM D2412 shall conform to the following Table:

Nominal ID (inches)	Min. Pipe Stiffness at 5% Deflection (psi)
4	50
6	50
8	50
10	50
12	50
15	42
18	40
24	34
30	28
36	22
42	20
48	18
60	14

- f. Minimum Pipe cover: 24-inches to finish grade.
 - g. Color: Black
 - h. Style: Watertight Bell and spigot with rubber-ring sealed gasket joint meeting AASHTO M252, M294 or ASTM F2306. The integral joints shall be watertight according to ASTM D3212.
 - i. Joints: Joint shall provide a minimum pull-apart strength of 400lbs. The bell shall be an integral part of the pipe. Joints shall remain silt-tight when subjected to a 1.5° axial misalignment.
 - j. Elastomeric gaskets must comply with ASTM F477. Install joints so that the elastomeric gasket will be compressed radially between the pipe bell and spigot to form a tight seal when assembled.
 - k. Wyes, tees, reducers, elbows, coupling, laterals, and other fittings must be molded or fabricated meeting the requirements of AASHTO M252, M294 or ASTM F2306.
 - l. Lubricant shall be applied to the bell and gasket during installation and must comply with pipe manufacturer's instructions.
2. Manufacturers:
 - a. N-12[®] WT as manufactured by Advanced Drainage Systems, Inc.
 - b. Prinsco Goldflo WT[®] Pipe
 - c. Hancor, Inc. – Blue Seal[®] WT IB pipe
 - d. Contech Eagle Corr PE[™] (Dual Wall)
 - e. Or approved equal

2.2 DRAINAGE STRUCTURES

- A. Description: As specified in [Section 33 05 13 - Manholes and Structures](#).

2.3 CONCRETE ENCASEMENT AND CRADLES

- A. Concrete:
 1. Description: Reinforced concrete, as specified in [Section 03 30 00 – Utility Cast-in-Place Concrete](#).
 2. Compressive Strength: 4,000 psi at 28 days, reinforced concrete, air-entrained rough-troweled finish.
- B. Reinforcement: As specified in [Section 03 30 00 - Utility Cast-in-Place Concrete](#).

2.4 MATERIALS

- A. Bedding and Backfill:

1. Bedding & Backfill: Bedding and Backfill shall be as specified in [Section 31 23 16 - Utility Trenching](#)

2.5 MIXES

- A. Grout: As specified in [Section 03 60 00 – Grouting](#)
- B. Concrete Encasements and Cradles:
 1. Class A concrete, as specified in [Section 03 30 00 – Utility Cast-in-Place Concrete](#).

2.6 ACCESSORIES

- A. Pipe Support Brackets: Galvanized structural steel coated with bituminous paint.
- B. Pipe Markers: As specified in [Section 33 05 26 - Utility Identification](#).
- C. Drainage Structures:
 1. Catch Basins, Inlets, Manholes and other Drainage Structures: As specified in [Section 33 05 13 - Manholes and Structures](#).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that trench cut is ready to receive Work.
- B. Verify that excavations, dimensions, and elevations are as indicated on drawings.

3.2 PREPARATION

- A. [Section 01 70 00 - Execution](#): Requirements for installation preparation.
- B. Remove large stones and other hard matter that could damage piping or impede consistent backfilling or compaction.
- C. Protect and support existing sewer lines, utilities, and appurtenances.
- D. Utilities:
 1. Maintain profiles of utilities.
 2. Coordinate with other utilities to eliminate interference.
 3. Notify Project Manager if crossing conflicts occur.

3.3 INSTALLATION

A. Excavation and Bedding:

1. Excavate pipe trench and providing sheeting and shoring as specified in [Section 31 23 16 – Utility Trenching](#).
2. Hand trim excavation for accurate placement of piping to indicated elevations.
3. Dewater excavations to maintain dry conditions to preserve final grades at bottom of excavation.
4. Level materials, maintaining optimum moisture content of bedding material, compacting subgrade shall conform to [Section 31 23 16 – Utility Trenching](#).
5. Cradle bottom 20 percent of diameter to avoid point load.

B. Piping:

1. Install pipe, fittings, and accessories according to ASTM D2321.
2. Install pipes in prepared trenches starting at the lowest point, with the spigot ends pointing in the direction of flow.
3. Seal joints watertight.
4. Place pipe on bedding meeting bedding requirements as specified in [Section 31 23 16 – Utility Trenching](#).
5. Unless otherwise required, all pipe shall be laid straight between the changes in alignment and at uniform grade between changes in grade.
6. The rubber gasket joint shall be made by properly lubricating the rubber gasket with a suitable vegetable compound soap before it is placed in the groove at the spigot end. The gasket shall be stretched over the spigot end of the pipe and carefully seated in the groove, with care taken to equalize the stress in the gasket around the circumference of the joint. The gasket shall not be twisted, rolled, cut, crimped, or otherwise injured or forced out of position during the closure of the joint. A feeler gauge shall be used to check the position of the rubber gasket after the joint has been assembled. Where a joint placement is found to be improper, the tested pipe section shall be removed, the gasket checked for damage, a new gasket installed, if necessary, the pipe re-laid and the gasket placement rechecked.
7. Pointing and bonding mortar at pipe connections to structures shall be plastic and of such consistency that it will readily adhere to the pipe and structure.
8. Install backfill at sides and over top of pipe
9. Compact to percent maximum density as specified in [Section 31 23 16 – Utility Trenching](#).
10. Install water stop at all pipe entry into structures.
11. Backfilling and Compaction:
 - a. As specified in [Section 31 23 16 – Utility Trenching](#).
 - b. Do not displace or damage pipe while compacting.

12. Pipe Markers: As specified in [Section 33 05 26 - Utility Identification](#).

C. Drainage Structures:

1. Catch Basins, Inlets, Manholes, and Other Drainage Structures: As specified in [Section 33 05 13 - Manholes and Structures](#).

3.4 TOLERANCES

A. [Section 01 45 00 - Quality Control](#): Requirements for tolerances.

B. Maximum Variation from indicated Pipe Slope: 1/8 inch in 10 feet.

3.5 FIELD QUALITY CONTROL

A. [Section 01 45 00 - Quality Control](#): Requirements for testing, adjusting, and balancing.

B. Request inspection by Project Manager prior to backfill in pipe zone and immediately after placing aggregate base over pipe in the pipe zone.

C. Testing:

1. If tests indicate that Work does not meet specified requirements, remove Work, replace, and retest.

2. Compaction Tests:

a. Comply with ASTM D1557, ASTM D698, AASHTO T180, and ASTM D6938.

3. Low-Pressure Air Test:

a. As specified in [Section 33 01 30 – Testing for Sanitary Sewer, Storm Drainage - Piping and Manholes](#).

4. Deflection Tests and CCTV Inspections:

a. As specified in [Section 33 01 30 – Testing for Sanitary Sewer, Storm Drainage - Piping and Manholes](#)

3.6 PROTECTION

A. [Section 01 77 00 - Closeout Requirements](#): Requirements for protecting finished Work.

B. Protect pipe and aggregate base from damage or displacement until backfilling operation is in progress.

END OF SECTION 33 41 13

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SECTION 40 05 07
PIPE HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Hangers and supports for all piping systems specified in Section 40 05 10.
- B. This section does not include pipe supports for fire sprinkler systems, pipe anchors, guides or seismic restraints.
- C. For seismic restraint requirements for piping, see Section 40 05 96.

1.2 REFERENCED SECTIONS

- A. The following Sections are referenced in this section
 - 1. Section 01 61 10 – Seismic Anchorage and Bracing
 - 2. Section 05 05 01 – Anchor Bolts and Anchoring Devices
 - 3. Section 40 05 10 – Piping Systems
 - 4. Section 40 05 96 – Seismic Restraints for Piping

1.3 QUALITY CONTROL

- A. Operating Conditions
 - 1. The hangers and supports specified in this section are provided to resist pipe loads occurring primarily in the downward (gravity) direction. For the purpose of pipe hanger and support selection, this section establishes pipe support classifications based on the operating temperatures of the piping contents. Pipe support classifications are as follows:
 - a. Hot Systems: A. 120°F to 450°F.
 - b. Ambient Systems: B. 60°F to 119°F.
 - c. Cold Systems: C-1. 33°F to 59° F, C-2. -20°F to 32°F.
- B. Hanger and Support Selection
 - 1. Select pipe hangers and supports as specified. Base selections upon the pipe support classifications specified in this section, the piping insulation thickness specified in Section 40 05 10, and any special requirements which may be specified in the contract documents.
 - 2. Review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the type of support to be used at each hanger point.
 - 3. Design and select hangers and supports to withstand all static and specified dynamic conditions of loading to which the piping and associated equipment may be subjected. As a minimum, consider the following conditions:
 - a. Weights of pipe, valves, fittings, insulating materials, suspended hanger components, and normal fluid contents.
 - b. Weight of hydrostatic test fluid or cleaning fluid if normal operating fluid contents are lighter.
 - c. Reaction forces due to the operation of safety or relief valves.
 - d. Wind, snow, or ice loadings on outdoor piping.

4. Size hangers and supports to fit the outside diameter of pipe, tubing,.
5. Where negligible movement occurs at hanger locations, use rod hangers for suspended lines, wherever practical. For piping supported from below, use bases, brackets or structural cross members.
6. For the suspension of size 2-1/2" and larger pipe and tubing, use hangers capable of vertical hanger component adjustment under load.
7. Provide supporting systems which provide for and control the free or intended movement of the piping including its movement in relation to that of connected equipment.
8. Where there is horizontal movement at a suspended hanger location, select hanger components to allow for swing. Do not permit the vertical angle of the hanger rod to exceed 4° at any time.
9. Do not permit contact between a pipe and hanger or support component, constructed of dissimilar metals. Prevent contact between dissimilar metals when supporting copper tubing by using copper-plated, rubber, plastic or vinyl coated, or stainless steel hanger and support components.
10. Unless otherwise specified, existing pipes and supports shall not be used to support new piping.
11. Unless otherwise specified, pipe support components shall not be attached to pressure vessels.
12. Stock hanger and support components shall be used wherever practical.

1.4 INDUSTRY STANDARDS

- A. This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between this section and the listed documents, the requirements of this section shall prevail.
- B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids).
- C. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by the organization or, if there are no replacement documents, the last version of the document before it was discontinued.
- D. Where document dates are given in the following listing, reference to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued, or replaced.

Reference	Title
AISC Manual of Steel Construction	American Institute of Steel Construction, Manual of Steel Construction, - 13th Edition
CBC	California Building Code
FEDSPEC WW-H-171e	Hangers and Supports, Pipe
MFMA-4	Metal Framing Manufacturer's Association, Metal Framing Standards Publication
MSS SP-58	Manufacturers Standardization Society Pipe Hangers and Supports— Materials, Design and Manufacture
MSS SP-69	Manufacturers Standardization Society Pipe Hangers and Supports— Selection and Application

1.5 SUBMITTALS

- A. Provide hanger and support locations, load calculations, and manufacturer layout and detail drawings as part of the submittals for equipment and piping coordination and installation drawings required in Section 40 05 10.
- B. The load and support design calculations shall be stamped and signed by a licensed Civil or Structural Engineer in the State of California. Comply with Section 01 61 10 and Section 05 05 01. Coordinate calculations with those required by Section 40 05 96.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. B-Line
- B. Carpenter & Paterson
- C. Kin-Line
- D. Anvil International
- E. Michigan
- F. Pipe Shields Incorporated
- G. Superstrut
- H. Unistrut
- I. Or equal
- J. Comply with MSS SP-69 and FEDSPEC WW-H-171e for pipe support components and MFMA-4 for framing systems

2.2 PRODUCTS

- A. Material
 - 1. Pipe hangers and supports, structural attachments, rack and trapeze supports, fittings and accessories: 316 stainless steel.
 - 2. Nuts, bolts, washers, and other fasteners: Type 316 stainless steel.
 - 3. Safety end caps on all framing channels.
 - 4. Comply with MSS SP-58 for supports and MFMA-4 for framing systems.
- B. Pipe Hangers and Supports
 - 1. Type 1 – Clevis Pipe Hanger, configuration and components equivalent to MSS and FEDSPEC Type 1.
 - a. Steel pipe (insulated): B-Line B3100, Anvil International 260, or equal, with insulation shield.
 - b. Steel pipe (uninsulated): B-Line B3100, Anvil International 260, or equal.
 - c. Cast and ductile iron pipe: B-Line B3102, Anvil International 590, or equal.
 - d. Copper pipe (uninsulated): B-Line B3104 CT, Anvil International CT-65, or equal.
 - e. Copper pipe (insulated): B-Line B3100, Anvil International 260, or equal, with insulation shield.
 - f. Plastic pipe: B-Line B3100 C, Carpenter & Paterson Fig. 100PVC, or equal.

2. Type 2 – J Pipe Hanger, configuration and components equivalent to MSS Type 5
 - a. Steel pipe: B-Line B3690, Anvil International 67, Michigan model 418, or equal.
 - b. Copper and plastic pipe: Michigan model 419, Unistrut J 1205N series, or equal.
3. Type 3 – Double Bolt Pipe Clamp, configuration and components equivalent to MSS and FEDSPEC Type 3.
 - a. Steel pipe (insulated): B-Line B3144, Anvil International 295, or equal, with insulation shield. Insulation shield is optional for hot and ambient systems.
 - b. Steel pipe (uninsulated): B-Line B3144, Anvil International 295, or equal.
 - c. Copper pipe (insulated only): B-Line B3144, Anvil International 295, or equal, with insulation shield.
4. Type 4 – Adjustable Roller Hanger, configuration and components equivalent to MSS Type 43 and FEDSPEC Type 44.
 - a. Steel pipe (insulated): B-Line B3110, Anvil International 181, or equal, with insulation shield.
 - b. Steel pipe (uninsulated): B-Line B3110, Anvil International 181, or equal.
 - c. Copper pipe (insulated only): B-Line B3110, Anvil International 181, or equal, with insulation shield.
 - d. Plastic pipe: B-Line B3110, Anvil International 181, or equal.
5. Type 5 – Single Pipe Roll, configuration and components shall be equivalent to MSS Type 41 and FEDSPEC Type 42.
 - a. Steel pipe (insulated): B-Line B3114, Anvil International 171, or equal, with insulation shield.
 - b. Steel pipe (uninsulated): B-Line B3114, Anvil International 171, or equal.
 - c. Plastic pipe: B-Line B3114, Anvil International 171, or equal.
6. Type 6 – Framing Channel Pipe Clamp
 - a. Steel pipe (uninsulated):
 - 1) Pipe size 3/8" and 1/2": 16-gage;
 - 2) 3/4" through 1 1/4": 14 gage;
 - 3) 1-1/2" through 3": 12-gage;
 - 4) 3 1/2" through 5": 11- gage;
 - 5) 6 and 8": 10-gage;
 - b. Michigan Model 431, Powerstrut PS 1100, Unistrut P 1109 series, or equal.
 - c. Steel pipe (insulated): Pipe clamp as described in Paragraph 2.02 B.6.a with insulation shield.
 - d. Copper (uninsulated) and plastic pipe:
 - 1) Pipe size 3/8" and 1": 16-gage;
 - 2) 1-1/4" and 1-1/2": 14-gage;
 - 3) 2" through 3": 12-gage;
 - 4) 4": 11-gage;
 - 5) Clamp: copper-plated, plastic coated or lined with dielectric material;
 - 6) Michigan model 432, Powerstrut PS 1200, Unistrut P 2024C and P 2024PC series, or equal.

- e. Copper pipe (insulated): Pipe clamp shall be as described in Paragraph 2.02 B.6.a with insulation shield.
7. Type 7 – U-Bolt Configuration equivalent to MSS and FEDSPEC Type 24.
- a. Steel pipe (uninsulated): Anvil International. 137, B-Line B3188, or equal.
 - b. Steel pipe (insulated): Anvil International. 137, B-Line B3188, or equal, with insulation shield.
 - c. Cast and ductile iron pipe: Anvil International. 137, B-Line B3188, or equal.
 - d. Copper pipe (uninsulated): Carpenter & Paterson Fig. 222 CT, B-Line B3501 CT, Anvil International. 137C, or equal.
 - e. Copper pipe (insulated): Anvil International. 137, B-Line B3188, or equal, with insulation shield.
 - f. Plastic pipe: Anvil International. 137C, Michigan model 151, B-Line B3188 C, or equal.
8. Type 8 – Adjustable Pipe Roll Support
- a. Steel pipe (insulated): B-Line B3122, Anvil International. 177, or equal, with insulation shield.
 - b. Steel pipe (uninsulated): B-Line B3122, Anvil International. 177, or equal.
 - c. Copper pipe (insulated only): B-Line B3122, Anvil International. 177, or equal, with insulation shield.
 - d. Plastic pipe: B-Line B3122, Anvil International. 177, or equal.
9. Type 9 – Welded Pipe Stanchion
- a. Minimum material thickness: standard schedule pipe, cut to match contour of the pipe elbow.
 - b. Limit use of this support to ambient systems only.
10. Type 10 – Pipe Stanchion Saddle and Yoke, comply with MSS Type 37 and FEDSPEC Type 38.
- a. Steel pipe (insulated): Carpenter & Paterson Fig. 125, B-Line B3090, or equal, with insulation shield.
 - b. Steel pipe (uninsulated): Carpenter & Paterson Fig. 125, B-Line B3090, or equal.
 - c. Cast and ductile iron pipe: Carpenter & Paterson Fig. 125, B-Line B3090 NS, or equal.
 - d. Copper pipe (uninsulated): Carpenter & Paterson Fig. 125, B-Line B3090, or equal, with insulation shield or lined with dielectric material.
 - e. Copper pipe (insulated): Carpenter & Paterson Fig. 125, B-Line B3090, or equal, with insulation shield.
 - f. Plastic pipe: Carpenter & Paterson Fig. 125, B-Line B3090, or equal.
11. Type 11 – Offset Pipe Clamp, Provided with configuration and components specified using standard designs offered by a pipe hanger component manufacturer.
- a. Steel pipe (insulated): B-Line B3148, Anvil International 103, or equal, with insulation shield.
 - b. Steel pipe (uninsulated): B-Line B3148, Anvil International 103, or equal.
 - c. Cast and ductile iron pipe: B-Line B3148 NS, Anvil International 103, or equal.
 - d. Copper pipe (insulated): B-Line B3148, Anvil International. 103, or equal, with insulation shield.

- e. Copper pipe (uninsulated): B-Line B3148, Anvil International. 103, or equal, lined with dielectric material.
 - f. Plastic pipe: B-Line B3148, Anvil International. 103, or equal.
 - g. Vertical pipe support applications: as specified above except do not use insulation shields for insulated pipe.
12. Type 12 – Riser Clamp, configuration and components equivalent to MSS and FEDSPEC Type 8.
- a. Steel pipe (insulated): B-Line B3373, Anvil International 261, or equal.
 - b. Steel pipe (uninsulated): B-Line B3373, Anvil International 261, or equal.
 - c. Cast and ductile iron pipe: B-Line B3373, Anvil International 261, or equal.
 - d. Copper pipe (insulated): B-Line B3373 CT, Anvil International CT-121, Michigan model 511, or equal.
 - e. Copper pipe (uninsulated): B-Line B3373 CT, Anvil International CT-121, Michigan model 511, or equal.
 - f. Plastic pipe: B-Line B3373, Anvil International. 261c, or equal.
13. Type 13 – Framing Channel Pipe Strap, configuration equivalent to MSS Type 26.
- a. Steel pipe (uninsulated): Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal.
 - b. Steel pipe (insulated): Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal, with insulation shield.
 - c. Copper pipe (uninsulated): Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal, with insulation shield or lined with dielectric material.
 - d. Copper pipe (insulated): Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal, with insulation shield.
 - e. Plastic pipe: Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal.
- C. Rack and Trapeze Supports
- 1. General
 - a. Unless otherwise specified, provide trapeze and pipe rack components minimum thickness of 12 gage, with a maximum deflection 1/240 of the span.
 - 2. Type 20 – Trapeze Pipe Support
 - a. For trapeze pipe support cross members, use framing channel as specified in Paragraph 2.02 E.5. For flat plate fittings, 1-5/8" square standard design manufactured by framing channel manufacturer, Unistrut P2471, B-Line B202-2, or equal.
 - 3. Type 21 – Pipe Rack Support
 - a. For post and cross members, use framing channel as specified in Paragraph 2.02 E.5. For pipe rack fittings, use standard design manufactured by framing channel manufacturer. For 90° fittings, use gusseted Unistrut P2484, B-Line B844, or equal. Provide post base fittings as specified in Paragraph 2.02 D.5.
- D. Structural Attachments
- 1. Type A –Insert For Concrete:
 - a. Concrete inserts: Comply with MSS and FEDSPEC Type 18.
 - b. Anvil International 282, Carpenter & Paterson Fig. 108, or equal.

2. Type B – Side Beam Bracket
 - a. Comply with MSS Type 34 and FEDSPEC Type 35.
 - b. Anvil International. 202, B-Line B3062, or equal.
3. Type C –Beam Clamp with Extension Piece
 - a. Comply with MSS and FEDSPEC Type 30.
 - b. Anvil International. 218 with Fig. 157 extension piece, B-Line B3054, or equal.
4. Type D – Beam Clamp with Eye Nut
 - a. Beam clamp and eye nut: forged stainless steel.
 - b. For configuration and components, comply with MSS and FEDSPEC Type 28.
 - c. Anvil International. 292, Carpenter & Paterson Fig. 297, or equal.
5. Type E – Framing Channel Post Base
 - a. Standard design offered by framing channel manufacturer.
 - b. Single channel: Unistrut P2072A, B-Line B280, or equal.
 - c. Double channel: Unistrut P2073A, B-Line B281, or equal.
6. Type F – Welded Beam Attachment
 - a. Comply with MSS and FEDSPEC Type 22. B-Line B3083, Anvil International. 66, or equal.
7. Type G – Welded Steel Bracket
 - a. Comply with MSS Type 32 and FEDSPEC Type 33 for medium welded bracket.
 - b. Comply with MSS Type 33 and FEDSPEC Type 34 for heavy welded bracket.
8. Type H –Bracket
 - a. Carpenter & Paterson Fig. 340, or equal.
9. Type J – Adjustable Beam Attachment
 - a. Carpenter & Paterson Fig. 151, B-Line B3082, or equal.
10. Type K – Double Channel Bracket
 - a. Wall channel: single channel framing channel as specified in Paragraph 2.02 E.5.
 - b. Cantilever bracket: double framing channel assembly, Unistrut P2542 through P2546, B-Line B297-12 through B297-36, or equal.
11. Type L – Single Channel Bracket
 - a. Wall channel: single channel framing channel as specified in Paragraph 2.02 E.5.
 - b. Cantilever bracket: a single framing channel assembly, Unistrut P2231 through P2234, B-Line B198-6, B198-12, B196-18 and B196-24, or equal.
12. Type M – Wall Mounted Channel
 - a. Wall channel: single channel framing channel as specified in Paragraph 2.02 E.5.
13. Type N – Pipe Stanchion Floor Attachment
 - a. Base plate: 1/2" minimum thickness.
 - b. Make anchor bolt holes 1/16" larger than the anchor bolt diameter.

- c. Fill space between the base plate and the floor with nonshrink grout.
- E. Accessories
- 1. Hanger Rods
 - a. Rods: threaded on both ends or continuous threaded and sized as specified.
 - 2. Weldless Eye Nut
 - a. Eye nut: forged stainless steel and complying with MSS and FEDSPEC Type 17.
 - b. Manufacturer: Anvil International. 290, B-Line B3200, or equal.
 - 3. Welded Eye Rod
 - a. Weld-eye rod closed. Make inside diameter of eye a bolt diameter 1/8" larger than the rod diameter.
 - b. Manufacturer: Anvil International. 278, B-Line B3211, or equal.
 - 4. Turnbuckle
 - a. Turnbuckle: forged stainless steel and complying with MSS and FEDSPEC Type 13.
 - b. Manufacturer: Anvil International. 230, B-Line B3202, or equal.
 - 5. Framing Channel
 - a. Framing channel: 1-5/8" square, roll formed, 12-gage.
 - b. Provide channel with a continuous slot along one side with in-turned clamping ridges.
 - c. Single channel: Unistrut P1000, B-Line B22, or equal.
 - d. Double channel: Unistrut P1001, B-Line B22A, or equal.
 - e. Triple channel: Unistrut P1004A, B-Line B22X, or equal.

2.3 THERMAL PIPE HANGER SHIELD

- A. Provide thermal shields at hanger, support, and guide locations on pipe requiring insulation.
- B. The shield shall consist of an insulation layer encircling the entire circumference of the pipe and a steel jacket encircling the insulation layer.
- C. Make the thermal shield the same thickness as the piping system insulation specified in Section 40 05 10.
- D. Use the standard shield for hot systems and the vapor barrier shield for cold systems.
- E. Use stainless steel band clamps where specified to ensure against slippage between the pipe wall and the thermal shield.
- F. Standard Shield
 - 1. Insulation
 - a. Hydrous calcium silicate, high density, waterproof.
 - b. Compressive strength: 100 psi average.
 - c. Flexural strength: 75 psi average.
 - d. K factor: 0.38 at 100°F mean.
 - e. Temperature range: 20°F to 500°F.

2. Steel Jacket
 - a. Stainless steel. Manufacturer's standard gauge supplied for the given pipe size.
 3. Connection
 - a. Butt connect to pipe insulation. Install with steel jacket and insulation flush with end.
- G. Vapor Barrier Shield:
1. Insulation
 - a. Hydrous calcium silicate, high density, waterproof.
 - b. Compressive strength: 100 psi average.
 - c. Flexural strength: 75 psi average.
 - d. K factor: 0.38 at 100°F mean.
 - e. Temperature range: 20°F to 500°F.
 2. Steel Jacket
 - a. Stainless steel. Manufacturer's standard gauge supplied for the given pipe size.
 3. Connection
 - a. Butt connect shield to pipe insulation.
 - b. Extend insulation 1" each side of steel jacket for vaportight connection to pipe insulation vapor barrier.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT LOCATIONS

- A. Locate hangers and supports as near as possible to concentrated loads such as valves, flanges, etc.
- B. Locate hangers, supports and accessories within the maximum span lengths specified in the contract documents to support continuous pipeline runs unaffected by concentrated loads. Indicate hanger and support locations and components on the piping layout drawings required by Paragraph 1.05. For pipe support submittals, provide a complete cross reference of each support by mark number, including the page number on which each mark number can be found. Set up the cross reference to permit review from the mark numbers to the drawings, not the other way around.
- C. Locate at least one hanger or support within 2' from a pipe change in direction.
- D. Locate hangers and supports to ensure that connections to equipment, tanks, etc., are substantially free from loads transmitted by the piping.
- E. Where piping is connected to equipment, a valve, piping assembly, etc., that will require removal for maintenance, support piping so temporary supports are not necessary.
- F. Locate pipe supports to prevent "pockets" from forming in pipe between supports due to excessive deflection under load from weight of pipe, medium in the pipe, insulation, valves and fittings.

3.2 INSTALLATION

- A. Construct welded and bolted attachments to the building structural steel which comply with the AISC Manual of Steel Construction. Unless otherwise specified, do not drill or burn holes in the building structural steel.

- B. Do not use hanger components for purposes other than for which they were designed. Do not use components for rigging and erection purposes.
- C. Install items to be embedded before concrete is poured. Fasten embedded items securely to prevent movement when concrete is poured.
- D. Use embedded anchor bolts that satisfy the 2010 CBC provisions instead of concrete inserts for supports in areas below water surface or normally subject to submergence.
- E. Install thermal pipe hanger shields on insulated piping at required locations during hanger and support installation. Make butt joint connections to pipe insulation at the time of insulation installation per manufacturer's recommendations.
- F. When hanger and support components are in contact with plastic pipe, make sure the components are free of burrs and sharp edges.
- G. Ensure rollers roll freely without binding.
- H. Roughen finished floor to a ¼ inch amplitude beneath structural attachments and framing channel post bases prior to grouting. Place grout, free of voids and foreign material, between base plate and floor.
- I. Cut and drill base plates to specified dimensions prior to welding stanchions or other attachments and prior to setting anchor bolts.
- J. Provide plastic or rubber end caps at the exposed ends of all framing channels that are located up to 7' above the floor.

3.3 ADJUSTMENTS

- A. Adjust hangers and supports to obtain required pipe slope and elevation.
- B. Use shims made of material that is compatible with the piping material.
- C. Adjust stanchions prior to grouting their base plates.

END OF SECTION

SECTION 40 05 10
PIPING SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Furnish all piping, including fittings, supports, and accessories shown on the Drawings and described herein, to completely interconnect all equipment and valves for a complete and operable system.

1.2 REFERENCED SECTIONS

- A. The following Sections are referenced in this Section:
1. Section 01 61 20 – Seismic Design Criteria
 2. Section 05 05 01 – Anchor Bolts and Anchoring Devices
 3. Section 09 96 00 – High Performance Coatings
 4. Section 10440 – Identifying Devices
 5. Section 40 05 07 – Pipe Hangers and Supports
 6. Section 40 05 96 – Seismic Restraints for Piping
 7. Section 40 80 01 – Testing Gravity Flow Pipelines
 8. Section 40 80 02 – Testing Pressure Piping
 9. Section 46 30 13 – Disinfection

1.3 SUBMITTALS

- A. Submittals shall demonstrate full compliance with all aspects of this specification, and shall include, but not be limited to, complete manufacturers' data on all pipe material, fittings, fasteners and hardware, gaskets, and coatings. Include the following information:
- B. Shop Fabricated Piping
1. Detailed pipe fabrication drawings showing special fittings and bends, dimensions, coatings, and other pertinent information.
 2. Layout drawing showing location of each pipe section and each special length; number or otherwise designate laying sequence on each piece.
 3. Pipe Wall Thickness: Identify wall thickness and rational method or standard applied to determine wall thickness for each size of each different service including exposed, submerged, buried, and concrete-encased installations for Contractor-designed piping.
 4. Hydraulic Thrust Restraint for Restrained Joints: Details including materials, sizes, assembly ratings, and pipe attachment methods.
 5. Thrust Blocks: Concrete quantity, bearing area on pipe, and fitting joint locations.
 6. Dissimilar Buried Pipe Joints: Joint types and assembly drawings.
 7. Anchor Bolt Calculations: Calculations and shop drawings shall be submitted with the pipe support submittal in accordance with Section 05 05 01 for all anchorage details. All calculations shall be prepared and signed by a civil or structural engineer currently registered in the State of California.

- C. Submit procedures for welding field joints of welded steel pipe (T.M-2P and T.W-1P) and welder qualifications.
- D. Contractor's below grade steel pipe submittal shall be completed and submitted to the Engineer within 30 working days from Notice to Proceed.
- E. Equipment and Piping Coordination and Installation Drawings
 - 1. The Drawings show only the general arrangements of the project equipment, piping and appurtenances. Contractor shall prepare and submit coordination and installation drawings that show the specific locations and dimensions of equipment, piping, valves, appurtenances, and related items, based upon dimensions for the actual concrete tank layout and equipment to be furnished from the accepted shop drawings.
 - 2. Drawing Requirements
 - a. The drawings shall be printed at a minimum scale of $3/8" = 1'$, on a minimum sheet size of $11" \times 17"$. Piping shall be shown in plan and section views, or alternatively, as isometric piping spool drawings.
 - b. Piping of nominal size less than 8" may be single line with scaled lay lengths and fittings. Piping of size 8" and greater shall be double line with scaled flanges, lay lengths, and fittings. Each pipe run shall be dimensioned.
 - c. All pipe supports, thrust restraints, and seismic bracing shall be shown. All devices shown on the mechanical layout and schematic drawings and the P&ID drawings shall be shown.
 - 3. During preparation of the drawings, Contractor shall provide interface and coordination between the tank shop drawings and all equipment suppliers and subcontractors, and, including as a minimum, the structural, architectural, mechanical, electrical, and instrumentation and control elements of the work.
 - 4. Submittals shall include load and sizing calculations for pipe supports, thrust restraints, seismic bracing and related items which have been prepared, stamped, and signed by a professional civil, mechanical, or structural engineer licensed by the State of California.
 - 5. Submittal and review of the coordination and installation drawings shall be completed at least 30 days prior to commencement of piping fabrication for each system product.
- F. Submit certifications to demonstrate compliance with Paragraph 2.01 (e.g., NSF 61 certification).
- G. Submit certified test reports as required herein and by the referenced standard specifications (Product Information).

1.4 REFERENCES

- A. ANSI – American National Standards Institute
- B. ASME – American Society of Mechanical Engineers
- C. ASTM – American Society for Testing and Materials
- D. AWWA – American Water Works Association
- E. NSF – National Sanitation Foundation

1.5 DESIGN REQUIREMENTS

- A. Design piping systems in accordance with the following:
 - 1. Buried Piping: H20-S16 traffic load with 1.5 impact factor, AASHTO Standard Specifications for Highway Bridges, as applicable.
 - 2. Thrust Restraints:
 - a. Design for 150 psi test pressure.
 - b. Allowable Soil Pressure: 2,500 pounds per square foot.
 - 3. Anchor Bolts for Pipe Supports: Comply with Section 01 61 20.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Pipe sizes are nominal inside diameter unless otherwise noted. All sizes of pipe shall be as called out on the Drawings and specified herein. All pipe and fittings delivered to the job site shall be clearly marked to identify the material, class, thickness, and manufacturer. All material shall be new and free of blemishes.
- B. Where only one type of pipe is called out, no substitutions shall be allowed. Piping materials of like kind shall be the product of one manufacturer. All pipe shall be the regular product of a firm which has successfully manufactured comparable pipe for at least five (5) years. Pipe shall be accordance with Section 27 of the Standard Specifications. Appurtenances shall be accordance with Section 10 of the Standard Specifications
- C. The Contractor is responsible for furnishing and installing all items necessary to make a complete and workable piping system. This includes, but is not limited to, valve boxes, insulating couplings and gaskets, piping specialties, and all other items required by the nature of the installation. Any item not specified herein but required by the installation shall be of first quality, equal in grade to similar materials specified herein, and shall comply with all applicable reference standards listed herein.
- D. All components and materials in contact with the potable water, process water to be treated to potable water, or liquids (e.g., chemicals) to be added to the process/potable water shall be lead-free and shall meet the requirements of California Code of Regulations Title 22 Chapter 16 Article 7 regarding direct and indirect additives.
- E. Paint exposed pipe in conformance with requirements of **Section 09 96 00**.

2.2 PIPE MATERIALS

- A. Pipe and Fitting Designation:
 - 1. Piping materials are identified by a "Type" designation in these specifications.
 - 2. Specific piping materials and other pertinent information is summarized for each pipe type.
 - 3. Pipelines are designated on the Drawings by a two-element code, the first representing the nominal pipe diameter and the second an abbreviation indicating the piping system.
 - 4. The following schedules, except where indicated otherwise on the Drawings, identify pipe type to be used for each piping system. Where the pipe type is not specifically identified on the Drawings, materials shall be selected based on the pipe service as listed in the following schedule and specified in subsequent articles of this specification.

B. Pipe Type Schedule:

Abbr.	System	Size	Service	Pipe Type	Notes
Process					
AS	Air Scour	All	E	SSP	
CFE	Combined Filter Effluent	≥ 16"	B, E, C	WSP	
FI	Filter Influent	≥ 16"	B, E, C	WSP	
FE	Filter Effluent	4" ≤ ϕ < 16"	B, C	DIP-B	
			E	DIP-F	
		≥ 16"	B, E, C	WSP	
FTW	Filter-to-Waste	≥ 12"	B, E, C	WSP	
OF	Overflow	4" ≤ ϕ < 16"	B, C	DIP-B	
			E	DIP-F	
		≥ 16"	B, E, C, S	WSP	
SA	Sample	All	B, E	SSP	
SW	Settled Water	≥ 16"	B, E, C	WSP	
WWD	Washwater Drain	≥ 16"	B, E, C	WSP	
TW	Treated Water	4" ≤ ϕ < 16"	B, C	DIP-B	
			E	DIP-F	
		≥ 16"	B, E, C	WSP	
WWS	Washwater Supply	4" ≤ ϕ < 16"	B, C, E	DIP-F	
		≥ 16"	B, E, C	WSP	
Chemicals					
HCL	Hydrochloric Acid	All	E	PVC-P	
			B	TUB inside HDPE	(2)
OF	Overflow	All	E	PVC-P	
POL	[Type] Polymer	All	E	PVC-P	
			B	TUB inside HDPE	(2)
SHC	Sodium Hypochlorite	All	E	PVC-P	
			B	TUB inside HDPE	(2)
V	Vent	All	B, E	PVC-P	

Abbr.	System	Size	Service	Pipe Type	Notes
Water					
1W	Plant Water (Potable)	< 4"	B, E	CUP	
		4" ≤ ϕ < 16"	B, C	DIP-B	
			E	DIP-F	
2W	Plant Water (Non-Potable)	< 4"	B, E	CUP	
		4" ≤ ϕ < 16"	B, C	DIP-B	
			E	DIP-F	
Drain					
D	Drain (Building)	All	B, E, C	CISP	
	Drain (Process)	< 4"	B, E	GSP	
		4" ≤ ϕ < 16"	B, C	DIP-B	
			E	DIP-F	
		≥ 16"	B, E, C	WSP	
	Drain (Chemical)	< 4"	B, E	PVC-P	
4" ≤ ϕ < 16"		B, C	PVC-P		
PD	Pumped Drainage	4" ≤ ϕ < 16"	B	DIP-B	
			E, C	DIP-F	
PFD	Perforated Drain	All	B	PVC-PF	
SD	Storm Drain	All	B	PVC-S	
SS	Sanitary Sewer	All	B	PVC-S	
Service: B=Buried; E=Exposed; C=Concrete Encased; S=Submerged; DC=Double Contained					

C. Cast Iron Soil Pipe (CISP)

1. Pipe and Fittings: Bell and spigot service weight cast iron soil pipe or no-hub cast iron soil pipe.
 - a. Bell and Spigot: ASTM A74.
 - b. No-Hub: Cast Iron Soil Pipe Institute Standard No. 301.
2. Joints:
 - a. Bell and Spigot.
 - b. No-hub joints may be used only in concealed locations. No-hub couplings shall be in accordance with Cast Iron Soil Pipe Institute Standard No. 301.
3. Gaskets
 - a. Bell and Spigot: Sewage and oil resistant, ASTM C564.

D. Copper Pipe (CUP)

1. Pipe: Copper, ASTM B88.
 - a. Buried: Type K (soft drawn).
 - b. Exposed: Type L (hard drawn).
2. Fittings
 - a. Soldered: Wrought copper, ANSI B16.22; or cast bronze, ANSI B16.18.

- b. Flared: AWWA C800 and ANSI B16.26.
 - 3. Joints
 - a. Buried: Soldered or flared.
 - b. Exposed: Soldered.
 - 4. Solder
 - a. ASTM B32, Alloy Grade E or HB. Solder and flux shall contain less than 0.2% lead.
- E. Ductile Iron Pipe – Bell & Spigot (DIP-B)
 - 1. Pipe
 - a. Ductile iron bell and spigot pipe, AWWA C151.
 - b. Minimum Pressure Class: 350.
 - 2. Fittings
 - a. Ductile iron with push-on joints or mechanical joints, AWWA C110 or C153.
 - b. Special fittings not available in ductile iron or cast iron pipe may be fabricated of welded steel pipe with a design pressure of 350 psi. Submit design and wall thickness to Engineer for review.
 - 3. Joints
 - a. Conforming to AWWA C111.
 - b. Push-on or mechanical joints, except where flanged joints are shown on the Drawings.
 - c. For all connections, provide restrained joints for: pipe and fittings on slopes greater than 20%; pipes and fittings that create a change in pipe size; fittings that result in a change of direction, whether the change is in the horizontal plane or a vertical plane; and plugs. Restrained joint length beyond fitting shall be as shown on the Drawings.
 - d. Manufacturers: One of the following, or equal.
 - 1) Push-on Joints
 - a) Fastite Joint as manufactured by American Cast Iron Pipe Company.
 - b) Pacific States Cast Iron Pipe Company.
 - c) Tyton Joint as manufactured by U.S. Pipe.
 - 2) Restrained Push-on Joints
 - a) United States Pipe and Foundry Company, TR Flex.
 - b) Pacific States Cast Iron Pipe Company, Thrust Lock.
 - c) American Cast Iron Pipe Company, Flex Ring or Lok-Ring.
 - 3) Restrained Mechanical Joints
 - a) Pacific States Cast Iron Pipe Company, Lock Mechanical Joint.
 - b) American Cast Iron Pipe Company, MJ Coupled Joint.
 - c) EBBA Iron, Megalug.
 - 4) Mechanical Groove Couplings
 - 5) Victaulic

4. Gaskets
 - a. Synthetic rubber compound in which the elastomer is nitrile or neoprene, conforming to AWWA C111. Lubricant for push-on joint piping shall be the pipe manufacturer's standard.
 5. Bolts and Nuts
 - a. Buried, for mechanical joints: Type 304 Stainless Steel.
 6. Lining and Coatings
 - a. Lining: Double thickness cement mortar lining seal coated with asphaltic material in accordance with AWWA C104, except where unlined pipe is specifically indicated on the Drawings.
 - b. Coating: Asphalt coating per AWWA C151.
- F. Ductile Iron Pipe – Flanged (DIP-F)
1. Pipe
 - a. Ductile iron pipe, AWWA C115.
 - b. Minimum Pressure Class: 53.
 2. Fittings
 - a. Ductile iron, AWWA C110.
 - b. Special fittings not available in ductile iron may be fabricated of epoxy lined and coated welded steel pipe with a design pressure of 350 psi. Submit design and wall thickness to Engineer for review.
 3. Joints
 - a. Ductile iron flange, in accordance with AWWA C115 and AWWA C110 and faced and drilled to 125 lb ANSI B16.1 standards.
 4. Bolts and Nuts
 - a. Above ground and exposed pipe: Corrosion resistant, high strength, low alloy carbon steel hex bolts, conforming to AWWA C115.
 - b. Underground, in concrete valve boxes, or underwater: Type 304 Stainless Steel.
 5. Gaskets
 - a. Gaskets for flanged joints shall be 1/16 in. thick (1/8 in. thick for pipes 12 in. and larger), rubber conforming to applicable parts of ANSI B16.12 and AWWA C115 and C207.
 - b. Gasket material shall be free from corrosive alkali or acid ingredients and suitable for use in potable water lines.
 - c. Gaskets shall be one piece with holes to pass bolts.
 6. Lining and Coatings
 - a. Lining: Double thickness cement mortar lining seal coated with asphaltic material in accordance with AWWA C104, except where unlined pipe is specifically indicated on the Drawings.
 - b. Coating: Exterior of exposed pipe shall be painted in accordance with Section 09 96 00.
- G. Galvanized Steel Pipe (GSP)
1. Pipe: Galvanized steel, ASTM A53, Schedule 40.

2. Fittings
 - a. Pressure Pipe Service: Galvanized malleable iron, screwed, ASTM A197 for materials, ANSI B16.3 Class 150 for dimensions (rated 300 psig WOG at 150°F).
 - b. Drain Pipe Service: Galvanized cast iron drainage pattern, ANSI B16.12.
 3. Joints
 - a. Threads: ANSI B2.1.
 - b. Unions: Galvanized malleable iron, ASTM A197 for materials and ANSI B16.39 for dimensions, with brass seats.
 - c. Thread Compound: Permatex No. 2; Crane equivalent; or equal; or teflon tape.
- H. High Density Polyethylene (HDPE) Pipe for Chemical Containment Service
1. Pipe: HDPE conforming to Iron Pipe Size dimensions, and in compliance with NSF 61. Shall meet or exceed requirements of ASTM D3350 for PE 4710 material with cell classification of 445474C, or better. Pressure rating shall be based on hydrostatic design stress of 1,000 psi at 73.4 degrees F. Pressure rating: 100 psig and nominal SDR of 21.
 2. Fittings: Long radius elbows manufactured in one continuous sweep from pipe as specified above with a bend radius of three times the pipe OD, as manufactured by Pipestar, "or-equal" shall be used for vertical elbows to transition pipe from buried to above grade. For horizontal buried elbows for chemical containment service, pipe should be bent to turn corners unless room does not allow, in which the long radius elbows specified above may be used.
 3. Joints:
 - a. Butt Fusion: Temperatures, times, and pressures of fusion shall be according to the manufacturer. Pipe joining equipment shall be provided by the pipe and fitting manufacturer.
 - b. Flanges: Stub end and polyethylene coated steel backing ring with ASME B16.5 Class 150 bolt pattern. Follow manufacturer's torque and tightening procedures
 - c. Bolting: ASTM A193/A193M Type 316 stainless steel Grade B8M heavy hex head or stud bolts and ASTM A194/A194M Grade 8M heavy hex head nuts. Stud bolts are not allowed when bolting to tapped flanges. Torque bolts per gasket and flange manufacturer recommendations.
 - d. Gaskets: Shall be low torque, full face to ASME B16.5 Class 150 dimensions and shall have two concentric, convex, molded rings between center hole and bolt hole circle in flange.
- I. Polyvinyl Chloride - Pressure (PVC-P)
1. Pipe: Schedule 80 as listed, Class 12454-B, rigid, unplasticized pipe made from polyvinyl chloride in accordance with ASTM D1784 and D1785.
 2. Fittings: Schedule 80 to match pipe, of the same material as the pipe, conforming to ASTM D2467.
 3. Joints: Joints shall be solvent weld, except that threaded or flanged joints are to be used where required at specific locations
 4. Cement: Solvent weld connections shall be made in strict accordance with the pipe manufacturer's recommendations using a solvent cement and primer (if recommended) meeting ASTM D2564.

5. Primer shall be IPS P-70 primer or equal.
 6. Solvent cement:
 - a. For Sodium Hypochlorite piping, use IPS 724 CPVC solvent cement or equal.
 - b. For Hydrochloric Acid piping, use IPS 724 CPVC solvent cement or equal.
 - c. For [Type] Polymer piping, use IPS 724 CPVC solvent cement or equal.
 7. Pipe Cleaner: In accordance with the pipe manufacturer's recommendations.
- J. Polyvinyl Chloride - Perforated Underdrain Pipe (PVC-PF)
1. Pipe and fittings: Plastic underdrain pipe, ASTM F758, Type PS 46 (SDR 35).
 2. Joints: Gasketed bell and spigot.
- K. Stainless Steel Pipe (SSP)
1. Pipe: Stainless steel, ASTM A312 or A778, TP 316L, Schedule 40S.
 2. Joints: Butt welded, except where flanged joints are required adjacent to valves or equipment.
 3. Fittings: Wrought stainless steel, ASTM A774, TP316L, ANSI B16.9 for dimensions.
 4. Flanges: Welding neck or slip-on, raised face, ASTM A182, TP316L, TP304L ANSI B16.5 for dimensions. Class 150, drilling to match adjacent accessories or valves.
 5. Gaskets: Full face gasket per ANSI B16.21, non-asbestos, EDPM.
- L. Tubing (TUB)
1. HDPE flexible tubing, Field Environmental Instruments Inc., Professional Plastics, or equal.
 2. Supply in continuous lengths such that tubing joints are only made in buildings or discharge locations and not inside containment pipe.
 3. Pressure rating: 150 psi at 73 deg F for sizes 1-inch and smaller.
 4. Fittings: HDPE barbed fittings with proprietary Barbloc coupling inserts with outside closure collar. Polypropylene coupling and collar, Saint Gobain or equal.
- M. Welded Steel Pipe (WSP)
1. Pipe
 - a. Steel pipe shall be cement mortar lined spiral or straight seam manufactured and furnished in accordance with AWWA C200.
 - b. All materials, fabrication and shop testing of steel pipe and steel pipe fabrications shall conform to the requirements of ANSI/AWWA C200. All dimensions shall conform to ANSI/AWWA C208.
 - c. The minimum thickness of plate for pipe from which fabrications are made shall be 1/4-inch. Steel for AWWA C200 pipe shall conform to the requirements of ASTM A36; ASTM A572, Grade 42; ASTM A570, Grades 33 and 36; or ASTM A283, Grade D.
 - d. Minimum wall thickness of butt-welded and flanged steel pipe shall be as presented in the table below:

8 inch and smaller	Schedule 40 unless otherwise noted
10 inch to 24 inch	0.25 inch unless otherwise noted
30 inch to 54 inches	0.312 inch unless otherwise noted

2. Fittings

- a. All fittings shall be rated for 150 psi, as a minimum working pressure.
- b. Steel pipe fittings shall conform to AWWA C208. Elbows to have a 22.5 degree maximum miter section angle, minimum two sections. Wyes, tees, crosses, and outlets to be reinforced in accordance with AWWA Manual M-11. Provide weld-o-lets for taps.

3. Joints

- a. For buried pipe, use welded joints, except where flanged or connected with flexible coupling where shown on the Drawings. For exposed pipe, use flanged or welded joints, except where couplings are shown on the Drawings
- b. Welded Joints
 - 1) Pipe with field welded joints shall be installed in accordance with AWWA C206.
 - 2) Welding operators, procedures, and details shall be qualified in accordance with AWWA C206.
 - 3) All welded pipe joints shall be field coated with cement mortar after installation as described herein.
 - 4) All welded pipe joints shall receive required field lining and patching after joint testing in accordance with AWWA C205.
- c. Flanges
 - 1) Slip-on or weld neck per AWWA C207, Class D, 125 lb.

4. Bolts and Nuts

- a. Nuts and bolts shall be electrozinc plated and of the sizes and quantities recommended in AWWA C207.

5. Gaskets

- a. Gaskets for flanged joints shall be sheet rubber gaskets in one piece conforming to AWWA C207 and ANSI B16.21, 1/8-inch thick.
- b. Gasket material shall be free from corrosive alkali or acid ingredients and suitable for use in potable water pipelines.
- c. The gasket shall be full-cut, with holes to pass bolts. Segmented straight-joint or interlocking gaskets will not be accepted.
- d. Blind flanges shall be gasketed with the entire face with the gasket cemented to the blind flange.

6. Lining and Coatings

- a. Buried steel pipe and fabrications shall be reinforced cement mortar coated in accordance with AWWA C205. Internal surfaces of the buried steel pipe and fabrications shall be cleaned and lined with cement-mortar in accordance with AWWA C205.
- b. Concrete-encased steel pipe shall be shop primed on external surfaces. Internal surfaces of the concrete-encased steel pipe shall be cleaned and lined with cement-mortar in conformity with AWWA C205.
- c. Exposed pipe shall be fusion bonded epoxy coated in accordance with AWWA C213 and finished painted as specified in **Section 09 96 00**.

Internal surfaces of the exposed steel pipe and fabrications shall be cleaned and lined with cement-mortar in conformity with AWWA C205.

- d. Prime coat all exposed metal surfaces (except for mortar or fusion bonded epoxy coated surfaces) in the shop prior to delivery to the site with a product compatible with the final coat. Surface preparation and application shall be as recommended by coating material manufacturer.

2.3 MISCELLANEOUS PIPING CONNECTIONS

- A. Refer to pipe material specifications for typical pipe joints. Furnish other joint devices where called for on the Drawings, as specified below.
- B. Flexible Couplings and Flanged Coupling Adapters (FCAs)
 1. Furnish and install flexible couplings and flanged coupling adapters where shown on the Drawings or required by installation.
 2. All couplings shall be restrained and suitable for a minimum working pressure of 150 psi.
 3. Longitudinal movement and angular deflections capabilities shall meet AWWA C219.
 4. Materials
 - a. Sleeves: Fabricated steel with fusion bonded epoxy coating suitable for potable water.
 - b. Followers: Cast iron, ductile iron, or steel with fusion bonded epoxy coating suitable for potable water.
 - c. Sleeve Bolts: Type 304 SS.
 - d. Gaskets: Synthetic rubber suitable for potable water.
 5. Manufacturers
 - a. Steel pipe or steel pipe sizes with identical outside diameters: Smith-Blair Type 411; Dresser Style 38; or equal.
 - b. Cast or ductile iron pipe with identical outside diameters: Smith-Blair Type 441; Dresser Style 138; or equal.
 - c. Connecting pipes with slightly different outside diameters: Rockwell Type 413 or R441; Dresser Style 62; or equal.
- C. Rubber Expansion Joints
 1. Type: Built-up single arch expansion joints with full flanges and retainer rings. Provide filled arch type for services with solids.
 2. Materials: EDPM cover over reinforced nylon or polyester body and EDPM tube with galvanized steel retainer ring. Cover shall have protective coating where installed outdoors.
 3. Pressure and Temperature Rating
 - a. Up to 12-inch-diameter: 190 psi, 250°F
 - b. Larger than 12-inch-diameter: 80 psi, 250°F
 4. Manufacturers: Proco Series 230; Garlock Style 204HP
 5. Provide galvanized steel control rod-compression sleeve assemblies for all rubber expansion joints, except where specifically omitted in Drawings. The number and size of the control rods shall be as required for the test pressure of the pipe system or 50 psi, whichever is greater.

6. Provide full size intermediate metal pipe flanges where rubber spool connects with wafer-style valves, lug-style valve, or other items that do not have full face metal flanges.
- D. Mechanical Groove Couplings
1. Mechanical groove couplings (segmental clamp joints) shall be used wherever shown on the Drawings. They may be substituted for flanged joints on steel cylinder or ductile iron pipelines if favorably reviewed by the Engineer.
 2. Type: AWWA C606, pressure rated at least 300 psi.
 3. Joints: Cut or roll groove, except shoulder joints may be used for steel pipe where the wall thickness is less than that allowed by AWWA 606 Table 4.
 4. Grooves:
 - a. Ductile Iron Pipe where Mechanical Groove Couplings are shown on the Drawings. Flexible joint, Table 2 (AWWA C606).
 - b. Ductile Iron Pipe where Flanges are shown on the Drawings. Rigid joint, Table 3 (AWWA C606).
 - c. Steel Pipe: Table 4 (AWWA C606)
 5. Gaskets: Nitrile.
- E. Dielectric Isolation
1. General
 - a. All metallic piping shall be dielectrically isolated from all other metal piping, hangers, brackets, steel reinforcing and all other metal structures. All piping shall be dielectrically isolated from piping or other materials constructed from dissimilar metals.
 2. Flange Insulators
 - a. Flange dielectric insulation sets shall contain full faced gaskets, full length sleeves, and double insulating washers or as specifically indicated on the Drawings. Insulation material for the flange insulation sets shall be phenolic resin and flange faced gaskets shall be neoprene faced phenolic resin. All insulating materials shall be of a type designated by the manufacturer as suitable for use at the operating and test pressures specified for the type of pipe on which the materials are to be installed.
 3. Wall Penetrations
 - a. All penetrations through reinforced concrete walls shall be constructed to prevent metal to metal contact between the pipe and reinforcing steel in the wall.
 4. Insulating Unions
 - a. Insulating unions shall meet Federal Specifications WW-U-532, Class 1 requirements for dimensional, strength, and pressure requirements. Insulation barrier shall limit galvanic current to 1 percent of the short circuit current in a corresponding metallic joint. The insulating material shall be impervious to water. Each connector shall match the type of material to which it connects.
 5. Pipe Supports
 - a. Any pipe hangers, supports, brackets and saddles installed on the buried side of dielectric insulators on the protected pipe shall be dielectrically isolated from the pipe by insertion of dielectric insulating material between the hanger and the pipe.

6. Testing

- a. All dielectric isolation devices shall be field tested for continuity isolation prior to coating and backfill.

2.4 PIPE SUPPORTS AND HANGERS AND SEISMIC RESTRAINTS

A. General

1. All piping shall be supported against sag, lateral and vertical movement in a manner which will prevent undue strain on any valve, fitting, pipe or piece of equipment. Unless otherwise indicated on the Drawings, exposed piping shall be supported at the base of all risers, at intervals not to exceed 5 ft on all horizontal runs of pipe 2 in. and smaller, at intervals not to exceed 8 ft on all horizontal runs of pipe 2-1/2 in. through 4 in., and at intervals not to exceed 12 ft on all horizontal runs of pipe larger than 4 in.
2. In addition, pipe supports shall be provided at changes in direction or elevation, adjacent to flexible couplings, at pipe connections to equipment and where otherwise shown.
3. Piping with flexible connections and/or expansion joints shall be anchored such that the intended uses of these joints are maintained in the piping system.
4. Piping shall be supported as described hereinafter and as shown by the pipe support details on the Drawings. Manufacturer's catalog figure numbers are typical of the types and quality of standard pipe supports and hangers to be employed.
5. No attempt has been made to show all required pipe supports in all locations, either on the Drawings or in the details. The absence of pipe supports and details on any Drawings shall not relieve the Contractor of the responsibility of providing a satisfactory piping support system in conformance with the functional and specific support spacing requirements of these specifications.

B. Hangers and Supports: Provide hangers and supports for piping systems in accordance with Section 40 05 07.

C. Seismic Restraints: Provide seismic restraints to brace piping systems in accordance with Section 40 05 96.

2.5 PIPE TAPS AND FITTINGS FOR INSTRUMENTATION

- A. The Contractor shall provide all taps, fittings, shutoff valves, etc., for instrumentation, flow control valves and other devices installed in pipelines.
- B. Provide pressure gauge taps where shown on Drawings. Gauge taps shall consist of a 1/2 in gage cock attached by threaded nipple to the pipeline, duct or equipment. Gage cocks shall be Robertshaw 1303, Ashcroft 1095, or equal. The exposed threads of each gage cock shall be protected by a brass plug.

2.6 MISCELLANEOUS PIPING ACCESSORIES

A. Polyethylene Encasement

1. The surfaces of all buried metallic pipe, fittings, and couplings shall be encased with two sheets of 8-mil minimum thickness polyethylene to form a continuous and all-encompassing layer of polyethylene between the piping and surrounding earth or backfill material.
2. Polyethylene material shall conform to the requirements of AWWA C105. Material shall be 8 mil, linear low density polyethylene (LLDPE) and shall be marked at two

foot intervals with manufacturer's name, year of manufacture, AWWA C105, film thickness and material, pipe size, and repair warning.

- B. Plastic Warning Tape
 - 1. Provide a single line of plastic warning tape 2.5 feet above the centerline of each buried pipe. Spread tape flat with message side up before backfilling.
 - 2. Manufacturers
 - a. Brady;
 - b. Seton;
 - c. Or equal.
 - 3. Dimension: 6-inch wide; 0.5 mil thick.
 - 4. Material: Inert plastic material suitable for direct burial.
 - 5. Color: Colors shall meet the APWA Color-Code standard for identification of buried utilities.
 - 6. Print two messages on the tape with bold letters approximately 2" high. Messages shall be repeated at maximum intervals of 2 feet.
 - a. First message: CAUTION CAUTION CAUTION
 - b. Second message: BURIED PIPE BELOW
- C. Link Seals
 - 1. Where shown on the plans, provide link seals and compatible wall sleeves with weep ring for wall penetrations.
 - 2. Use manufacturers recommended service designation unless noted otherwise.
 - 3. Type: Linked rubber sealing elements and pressure plates tightened together with stainless steel bolts.
 - 4. Manufacturers
 - a. Thunderline Corporation;
 - b. Calpico;
 - c. Or equal.

PART 3 - EXECUTION

3.1 PREPARATION AND HANDLING OF PIPE

- A. Each pipe and fitting shall be carefully inspected before the exposed pipe or fitting is installed or the buried pipe or fitting is lowered into the trench. The interior and exterior protective coatings shall be inspected, and all damaged areas, which are repairable in the opinion of the Engineer, shall be patched in the field with material similar to the original. Pipe unable to be repaired shall be removed from the project site and replaced with new, undamaged pipe. Clean ends of pipe thoroughly. Remove foreign matter and dirt from inside of pipe and keep clean during and after laying.
- B. Use proper implements, tools, and facilities for the safe and proper protection of the pipe. Carefully handle pipe in such a manner as to avoid any physical damage. Do not drop or dump pipe into trenches.

3.2 PIPING INSTALLATION

A. General

1. All pipes shall be carefully placed and supported at the proper lines and grades and, where possible, shall be sloped to permit complete drainage. Piping runs shown on the Drawings shall be followed as closely as possible, except for minor adjustments to avoid architectural and structural features. If major relocations are required, they shall be approved by the Engineer.
2. Wherever a pipe three inches in diameter and larger passes from concrete to earth, a flexible pipe coupling, shall be installed within 1 foot of the concrete. Particular care shall be taken to ensure a full support of the pipe in the earth between and beyond the joints.
3. When installing buried PVC pipe, it shall be "snaked" in the trench. In addition, PVC pipe shall not be laid when temperature is 32°F, or below. Piping shall be installed without springing or forcing the pipe in a manner which would set up stresses in the pipe, valves, or connected equipment.

B. Exposed Pipe

1. Exposed pipe shall mean any pipe not buried or encased in concrete. In erecting exposed pipe a sufficient number of screw unions, flanged or grooved end type joints shall be used to allow any section or run of pipe to be disconnected without taking down adjacent runs. Flanges and grooved couplings shall be employed on pipes 2-1/2 inches and larger. The provision of an adequate number of appropriate take-down fittings must be rigidly adhered to whether or not such fittings are indicated on the Drawings. Take-down fittings shall also be provided within two feet of threaded valves and other appurtenances. Where piping passes through concrete or masonry walls, take-down fittings shall be employed within 3 feet of the wall.
2. All exposed pipelines shall accommodate expansion and contraction forces by the use of expansion joints, anchors, and pipe guides. Where pipes cross structure expansion joints, rubber spherical molded type pipe expansion joints with restraining rods shall be installed whether specifically shown or not.
3. All unrestrained joints in pressure pipelines, including bell and spigot, flexible couplings, expansion joints and flange adapters shall have tension bars (tie rods) provided in accordance with AWWA M11 Design Manual, Figures 19.15 and 19.16, and Tables 19.7 and 19.8. Thrust protection shall be for 1-1/2 times the specified test pressure for the pipe.

C. Buried Pipe

1. General

- a. All buried pipe shall be prepared as herein before specified and shall be laid on the prepared granular base and bedded to ensure uniform bearing. No pipe shall be laid in water or when, in the opinion of the Engineer, trench conditions are unsuitable. Joints shall be made as herein specified for the respective types. Take all precautions necessary to prevent uplift and floating of the pipe prior to backfilling.
- b. Where pipe grade elevations are shown on the Drawings, install the pipe with straight grades between the indicated elevations. Where no pipe grade elevations are shown on the Drawings, install buried piping with at least 3 feet of cover to finished grade. Where piping crosses under buried electrical ducts, provide at least 4 feet 6 inches of cover.

- c. Provide each pipe with a firm, uniform bearing for its full length in the trench except at field joints. Do not lay pipe in water or when trench conditions or weather are unsuitable for such work.
- d. Protect buried piping against thrust by use of restrained pipe joints and/or thrust blocks. All exposed free pipe ends shall be securely braced. Cap or plug pipe ends that are left for future connections as shown on the Drawings and in a manner favorably reviewed by the Engineer.
- e. Piping under slabs and structures shall be encased in concrete unless otherwise directed by the Engineer.
- f. Where piping leaves a structure or concrete encasement, provide a joint capable of angular deflection within 12 inches of the structure for pipes 12-inch and smaller, or as shown on the Drawings for larger pipe sizes. Conform to details on the Drawings where such details are shown.
- g. Do not pull bell and spigot, gasketed joints more than 50% of the maximum deflection permitted by the pipe manufacturer.
- h. Coat bolts on buried flanges or other buried appurtenances in accordance with Section 09 96 00. Wrap the appurtenance with polyethylene encasement and tape the encasement tightly closed to the pipe.

2. Gravity Lines

- a. Laying of gravity pipelines shall proceed upgrade with the spigot ends pointing in the direction of flow. Each piece shall be laid true to line and grade and in such manner as to form a close concentric joint with the adjoining pipe and to prevent sudden offsets in the flow line. As the work progresses, the pipe interior shall be cleared of all dirt and debris of every description. Where clearing after laying is difficult because of small pipe size, a suitable swab or squeegee shall be kept in the pipe and pulled forward past each joint immediately after jointing has been completed. Pipe shall not be laid when the condition of the trench or the weather is unsuitable. At times when work is not in progress, open ends of pipe and fittings shall be closed.

3. Corrosion Protection

- a. All buried metal parts such as valves and bolt-ups not cement mortar coated shall be coated with two coats of bitumastic in accordance with Section 09 96 00, and encased with two sheets of 8-mil minimum thickness polyethylene to form a continuous and all-encompassing layer of polyethylene between the protected metal and surrounding earth. All polyethylene shall be secured in place with 10-mil polyethylene tape.

4. Dielectric Connections

- a. Where pipes of dissimilar metals are connected, a dielectric insulator shall be provided. Where copper pipe is supported from hangers, it shall be insulated from the hangers; or copper plated hangers shall be used.
- b. Dielectric insulators shall be installed on the first exposed flanges or couplings of pipes which are connected to buried piping. For this purpose, an insulating joint or connection shall be provided on exposed existing and new piping which requires cathodic protection, within ten feet of each point of burial. Where connections are made between existing ferrous metal piping and new piping which is to receive cathodic protection, a dielectric insulator shall be installed.
- c. Insulating flange gasket sets shall be installed at the specified locations. All insulating components shall be cleaned of all dirt, grease, oil and other foreign materials immediately prior to assembly. Bolt holes in mating flanges shall be properly aligned at the time bolts and insulating sleeves

are inserted to prevent damage to the insulation. After flanged bolts have been tightened, each insulating washer shall be inspected for cracks or other damage. All damaged washers shall be replaced. After assembly, resistance between each bolt and flange shall be measured with an approved ohmmeter, and the minimum resistance shall be 50,000 ohms. All insulating flanged joints shall be coated as shown.

- d. Insulating unions shall be installed at the specified locations. Joint compound or thread tape shall be applied to male threads only. Piping shall be worked into place without springing or forcing. Backing off to permit alignment of threaded joints will not be permitted. Threads shall be engaged so that no more than 3 threads remain exposed.

5. Locating Wire

- a. All runs of water pipe, including services, shall have a No. 10 gauge solid soft drawn copper wire laid along the pipe to facilitate locating the pipe at a later date. The wire shall be stubbed up inside each valve box. Continuity test shall be conducted on each splice at all locations.

D. Installation Specifics

1. CIPS

- a. Bell and Spigot: Fold and insert one-piece rubber gasket into properly cleaned hub. Apply lubricant to gasket and to spigot. Lubricant shall be a type recommended by the pipe and gasket manufacturers. Push or draw spigot into gasketed hub with a pulling tool devised especially for this purpose.
- b. No Hub: Install in accordance with Cast Iron Soil Pipe Institute Pamphlet No. 100.

2. DIP-B

- a. Install buried pipe in accordance with AWWA C600.
- b. Support and brace encased pipe to support the pipe and to prevent movement during testing and placement of the concrete encasement. The braces and supports shall be erected of materials and by methods that will prevent any future contact of the pipe with the environment surrounding the encasement.
- c. Pull the slack out of restrained joints after they are made up.
- d. Provide an insulated flanged joint on all buried ductile iron piping 6 inches in diameter and larger within 2 feet of each structure. Provide an electrolysis test station with a pair of leads on each side of the insulated flange.
- e. Wrap buried pipe with polyethylene encasement. See Paragraph 3.04.

3. DIP-F

- a. Flanged joints shall be made up tight with care being taken to avoid undue strain in the flanges, fittings, and other accessories.
- b. Bolt holes shall be aligned for each flanged joint. Bolts shall be full size for bolt holes; use of undersize bolts to make up for misalignment of bolt holes or for any other purpose will not be permitted.
- c. Adjoining flange faces shall not be out of parallel to such a degree that the flanged joint cannot be made watertight without overstraining the flange. Any flanged pipe or fitting whose dimensions do not allow the making of a proper flanged joint as specified herein shall be replaced by one of the proper dimensions.
- d. Clean flanges before jointing is started.

- e. Buried flanged pipe connections shall be made with the smallest practical "bell" hole. After the joint is completed take special care to completely fill the "bell" hole under and around the pipe with compacted backfill.
4. GSP
- a. Remove all burrs from ends of pipe, and clean threads of all oil and chips.
 - b. Threaded joints shall have connections made metal to metal tight. Coat male threads with joint lubricant. Properly tape wrap joints.
5. PVC-P, PVC-PF, and PVC-S
- a. Place PVC pipe within the installation areas at least 24 hours prior to installation to permit temperature equalization.
 - b. Cut pipe ends squarely, ream and deburr inside and out.
 - c. Solvent Weld Joints: Clean pipe ends and sockets and join in strict conformance with the pipe manufacturer's instructions. Make joints in accordance with ASTM D2855. Handle solvent cements and primers in accordance with ASTM F402.
 - d. Threaded Connections (PVC-P): Use a short nipple, threaded at one end, socket at the other. Provide thread sealant in accordance with the pipe manufacturer's recommendations. Take care not to overtighten the connection.
6. SSP
- a. Install and weld in accordance with CGA G-4.4 and ANSI B31.1. Back purge all welds with cover gas. Seal weld all slip-on flange.
 - b. Provide anti-seize compound on threaded connections.
 - c. Temporarily plug or cap all points of connection to exclude moisture, dust or other contaminants or impurities prior to being connected.
7. WSP
- a. Field welding of joints shall be in accordance with AWWA C206.
 - b. Acceptance of field welds will be based on visual inspection and non-destructive testing by the Engineer while the welds are being made and after they are completed. Hand or power wire brush each weld thoroughly after completion to facilitate the inspection. Correct defects not complying with AWS Code D1.1 Sections 3.6 and 8.15. Determine the cause of defects and take corrective measures to prevent a reoccurrence.
 - c. Joint Protection (Buried Pipe)
 - 1) Exterior: After steel pipe section has been laid, clean the exposed metal at the exterior space at the joint. Wrap the joint with a strip of woven fabric (diaper) and band around the pipe at each side of the joint. The fabric shall be of such a weave as to allow the escape of air and excess water but prevent escape of mortar. Pour the joint full of grout (1 part cement to 1 part fine aggregate with sufficient water to form a consistency of thick cream) through a space in the woven fabric slightly to one side of the top. Rod the grout with a beaded wire or chain as it is poured into the joint. Immediately after completing the exterior joint, place damp earth over and around the joint to prevent rapid drying.
 - 2) Interior: The inside joints of steel pipe 24 inches and larger shall be cleaned and thoroughly wetted before being filled with stiff cement mortar and finished off smooth by troweling or other equivalent method as approved. The inside joints of pipe less than 24 inches shall be mortared as specified in AWWA C205. Furnish

sufficient swabs of the proper size and shape for use by the installation Contractor to remove excess mortar from the joints inside pipes with diameters less than 24 inches. These swabs shall be of rubber and capable of being inflated to the proper size for their intended use. The swabs shall be equipped with rings, straps, or similar devices which will permit a rope or cable to be attached to pull the swab through the pipe without deforming the swab to the point where the inside joint is not wiped clean.

3.3 COUPLING INSTALLATION

A. Flexible Couplings and FCAs

1. Prior to installation, thoroughly clean oil, scale, rust, and dirt from the pipe to provide a clean seat for the gasket. Wipe gaskets clean before they are installed.
2. If necessary, flexible couplings and flanged coupling adapter gaskets may be lubricated with soapy water or manufacturer's standard lubricant before installation on the pipe ends.
3. Install in accordance with the manufacturer's instructions and recommendations.
4. Tighten bolts progressively, drawing up bolt on opposite sides a little at a time until all bolts have a uniform tightness. Workers tightening bolts shall be equipped with torque-limiting wrenches.

B. Flexible Expansion Joints

1. Install in accordance with manufacturer's instructions and recommendations.
2. Connect expansion joints only to full-face metal flanges.
3. Install control rod-compression sleeve assemblies with control rod nuts snug, to relieve stress on adjacent pipe, except at buried locations. Comply with manufacturer's instructions.
4. Paint buried galvanized steel retainer rings, bolts and other appurtenances in accordance with [Section 09 96 00](#).

3.4 INSTALLATION OF MISCELLANEOUS PIPING ACCESSORIES

A. Polyethylene Encasement

1. All polyethylene shall be secured in place with 10-mil polyvinyl tape. Installation shall conform to requirements of AWWA C105, Method A. Excess slack width in the polyethylene tube shall be taken up to make a snug, but not a tight fit, and secured with an adhesive tape wrapping around the pipe at the quarter points of each pipe length.
2. Any rips, punctures or other damage to the polyethylene sleeve shall be repaired with two layers of adhesive tape or a short length of polyethylene tube cut open, wrapped around the pipe, and secured in place.

3.5 PIPE IDENTIFICATION

- A. Identify all exposed piping in the project by painting, banding, system name labels, and direction arrows.
- B. Before painting, banding, and labeling, identify all pipes with wired-on cardboard tags showing the proposed marking for review by the Engineer.
- C. Paint the exposed pipes with the appropriate paint system specified in [Section 09 96 00](#) and provide pipe markers per the schedule in [Section 10440](#).

3.6 CLEANING

- A. The interior of all pipelines shall be thoroughly cleaned of all dirt, loose scale, sand, and all foreign material prior to connection of pipe to equipment, control and regulating devices, and instrumentation and prior to testing. Pump suction lines shall be cleaned prior to operation of pumps.
- B. Cleaning shall be accomplished by flushing with water at a velocity of at least 3 feet per second or by pulling a tightly fitting cleaning ball or swab through the pipe.
- C. No test shall commence until the pipeline is completely cleaned to the satisfaction of the Engineer.

3.7 FIELD TESTING

- A. Pressure Pipelines: All pressure pipelines installed in this project shall be subject to field and acceptance tests as specified in Section 40 80 02.
- B. Gravity Pipelines: All gravity pipelines installed in this project shall be subject to field and acceptance tests as specified in Section 40 80 01.

3.8 DISINFECTION

- A. Clean and disinfect potable water systems in accordance with the procedures in Section 46 30 13.
- B. Disinfection shall follow successful pressure testing.
- C. All new potable water pipe sections shall be disinfected prior to making final connection to existing active operating pipelines.

END OF SECTION

SECTION 40 05 51
GENERAL REQUIREMENTS FOR VALVES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Requirements for valves.

1.2 REFERENCED SECTIONS

- A. The following Section is referenced in this Section:
 - 1. Section 40 05 10 – Piping Systems

1.3 REFERENCED SPECIFICATIONS

- A. Conform to the requirements of the City of San Gabriel as modified herein.

1.4 SUBMITTALS

- A. Provide the following information, at a minimum:
 - 1. Shop drawings
 - a. Valves and actuators
 - 2. A schedule of valves indicating the label location, attachment method, and proposed label text for each valve.
 - 3. A schedule of responsible manufacturers for the project and contact information, planned site visits, and compliance tests to be performed.
 - 4. Design calculations, test and performance data, and other information required to substantiate that the valve units proposed will meet the performance requirements specified and shown.
 - 5. Protective Coatings: Manufacturer's data.

1.5 DEFINITIONS

- A. Responsible Manufacturer: Manufacturer or manufacturer's representative who will ensure satisfactory performance of equipment.
- B. Valve: Device for mechanically regulating pipeline or open-channel flow.
- C. Actuator: Devices added to obtain mechanical advantage or power assist in operation.

1.6 RESPONSIBLE MANUFACTURER

- A. Furnish, adjust, test, and ensure satisfactory performance of each valve.
- B. Provide any field adjustments, settings, and tests required for satisfactory performance of each valve at no additional cost to Owner.

1.7 QUALITY ASSURANCE

- A. Unless specified otherwise, factory test each valve body with a test pressure equal to twice the listed working pressure rating.
- B. Submit a certified copy of the pressure test reports for all valves over 12 inches in nominal size prior to shipping valves to the Site. Format these test reports per the requirements of the applicable reference standards.

- C. Storage and Preparation for Installation
 - 1. Package and store valves to prevent exposure to sunlight, chemical exposure, and atmospheric pollution.
 - 2. Inspect each valve prior to installation for damage. Repair any damage to seats, machined surfaces, or protective coatings before installation. Clean each valve to remove any dirt and debris from the interior surfaces and seat areas. Install valves in the closed position.
 - 3. Some valves must be installed with seats or seat adjustment rings on the downstream side of the valve. Determine these requirements prior to installation and install the valve in the correct orientation.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide valves, gates, actuators, stem extensions, and other accessories as indicated on the Drawings or specified. All valves shall be new and of current design. For valves of the same type, provide identical valves supplied by a single manufacturer.
- B. Provide valves and actuators with the name of the manufacturer, nominal size, flow direction arrow, design working pressure, and the reference standard cast in raised letters or indelibly marked on an appropriate part of the body.
- C. Provide valves and actuators designed for submerged service for the following locations
 - 1. Located outdoors
 - 2. Within a building below the adjacent finished grade
 - 3. In vaults
 - 4. Where otherwise indicated. All other units shall be weather-tight and suitable for outdoor service.
- D. Provide buried valves with valve boxes and covers where indicated.
- E. Flanges, gaskets, and bolts for valves: in accordance with Section 40 05 10.
- F. Unless otherwise specified, all interior bronze parts of valves shall conform to the requirements of ASTM B62.
- G. Wetted parts shall be lead-free as defined by California AB1953, California Prop-65, or the most stringent of current regulations.

2.2 PROTECTIVE COATINGS

- A. Coat ferrous surfaces in water passages of all valves of size 2 inches and larger and exterior surfaces of valves and actuators, with epoxy per AWWA C550, unless otherwise specified in the valve specification.
 - 1. Interior Surfaces:
 - a. Minimum dry film thickness: 8 mil
 - b. NSF/ANSI 61 approved.
 - 2. Exterior Surfaces:
 - a. Above ground:
 - 1) Minimum dry film thickness: 8 mil
 - b. Buried, submerged or in blow ground vaults:
 - 1) Minimum dry film thickness: 12 mil

- B. Do not coat flange faces or bronze and stainless steel surfaces in water passages.
- C. Coat exterior bronze and stainless steel surfaces using the same system as the associated piping.
- D. Provide holiday-free protective coatings.

2.3 VALVE ACTUATORS

- A. Furnish valves and gates with an actuator as indicated in the valve Technical Specification.
- B. Assemble valve actuators to the valve, adjust, and test the completed unit by Responsible Manufacturer prior to shipment to the Site.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

- A. Install valves per the manufacturer's written instructions and as indicated on the Drawings and specified.
- B. Fit, support and brace gates to prevent warping, binding, and bending under all operating conditions. Accurately position and support embedded parts cast into concrete during concrete placement.
- C. Assembly of Valves and Piping
 1. Install valves with piping per Section 40 05 10 and per this Section.
 2. Install valves with piping prior to the assembled piping or attached supports being cast into concrete or attached to supports.
 3. Sequence construction and operations so that the adjacent piping supports the valves, and so that the valves do not support the piping. Where permanent supports are located at valves, install the supports after the piping and valves have been installed as a completed assembly on temporary supports.
 4. Install piping and valve assemblies so that the piping does not exert forces on the valves from settlement or assembly operations.
 5. Correct piping alignment deviations before the valve is joined to the piping.
 6. Unless shown otherwise, install butterfly, plug, and ball valves with the shafts in the horizontal position.
 7. Install gates, gate valves, and other types of valves with the stems in the vertical position.
 8. For manually operated valves 3 inches in nominal size and smaller, orient the valve operators and indicators to be visible to the operator.
- D. Install floor boxes, valve boxes, extension stems, and floor stands vertically centered over the operating nut, with couplings as required. Adjust the elevation of the box top to conform with the elevation of the finished floor, grade, or pavement at the completion of the Work. Support boxes and stem guides during concrete placement to maintain vertical alignment and proper orientation.

3.2 TESTING

- A. Pressure test valves as part of the pipeline testing. Demonstrate valve operation (open/close) after the valve is installed including valve box and riser, as appropriate.
- B. Following installation, Owner may conduct holiday test for valves larger than 30-inch.

END OF SECTION

SECTION 40 05 57.13
MANUAL VALVE AND GATE OPERATORS AND
OPERATOR APPURTENANCES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Manual operators for valves and gates, and operator appurtenances.
- B. Contractor shall provide all tools, supplies, materials, equipment, and labor necessary for furnishing, installing, adjusting, and testing of valve actuators.
- C. Provide manual operators as indicated on the Plans.

1.2 REFERENCED SECTIONS

- A. The following Section is referenced in this Section:
 - 1. Section 46 05 60 – Valves and Appurtenances

1.3 SUBMITTALS

- A. Manufacturer's catalog information and other data confirming conformance to design and material requirements.
- B. Submit shop drawings for actuators as part of the submittals for the associated valves in accordance with Section 40 05 60.
- C. Submit design calculations showing the required valve operation torques and the design torque provided by each actuator.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Supplier shall supply and mount all actuators, including any type of manual or powered actuators, on the valves at the factory. Each valve and actuator shall be shipped as a unit.
- B. Each actuator shall have sufficient torque capacity and features to seat, unseat, and rigidly hold in any intermediate position the valve it controls under the operating conditions for the valve.
- C. Provide each actuator with an externally mounted mechanical valve position indicator.
- D. Each valve body or operator shall have cast thereon the word "OPEN", an arrow indicating the direction to open, and flow direction arrows.

2.2 OPERATORS

- A. General:
 - 1. Unless otherwise indicated, nonburied valves shall have an operating wheel, on the actuator. Buried valves shall have AWWA 2-inch operating nuts and non-rising stems. Unless specified otherwise, the direction of rotation of the operator shall be counterclockwise for opening.
- B. Wrench Nuts, Boxes, and Guides:
 - 1. Wrench nuts shall comply with Section 3.15 of AWWA C500. A minimum of two operating keys, but no fewer than 1 key per every 10 valves, shall be provided for operation of the wrench nut operated valves.

C. Gear Actuators

1. Unless otherwise noted, gear actuators shall be provided for the following.
 - a. Valves larger than 12 inches in nominal size
 - b. Buried valves that have the operating shaft mounted horizontally
 - c. Where specified or shown
 - d. Where a lever or wheel operator effort would otherwise be greater than 60 foot -pounds of torque or 60 pounds of force at the rim of the wheel or lever
2. Gear actuators shall be of the worm or helical gear type with the output shaft perpendicular to the valve shaft and a removable hand wheel mounted on the output shaft. Except as required herein, the gear actuators shall conform to AWWA C504 and shall be certified.
3. Actuators shall be capable of being removed from the valve without dismantling the valve or removing the valve from the line.
4. Gearing shall be machine-cut steel designed for smooth operation. Bearings shall be permanently lubricated, with bronze bearing bushings provided to take all thrusts and seals and to contain lubricants. Housings shall be sealed to exclude moisture and dirt, allow the reduction mechanisms to operate in lubricant, and be of the same material as the valve body.
5. Manual input effort to the handwheel shall be a maximum of 40 foot pounds for operating the valve from full open to full close, under any operating conditions. Gear operators shall indicate valve position and have adjustable stops. Maximum handwheel size shall be 24 inches in diameter. Minimum handwheel size shall be 12 inches.

2.3 OPERATOR APPURTENANCES

A. Valve Boxes:

1. Valve boxes shall be cast iron and shall have suitable base castings to fit properly over the bonnets of their respective valves and heavy top sections with stay-put covers. Covers shall be hot-dip galvanized.

B. Floor Boxes:

1. Floor boxes shall be hot-dip galvanized. Where the operating nut is in the concrete slab, the floor box shall be bronze bushed. Where the operating nut is below slab, the opening in the bottom of the box shall be sufficient for passage of the operating key. Floor boxes for operating nuts recessed in concrete shall be standard cast iron boxes cast into the concrete, with fastening top by Clow, or equal.

C. Adjustable Shaft Valve Boxes:

1. Adjustable shaft valve boxes shall be concrete or cast iron Brooks No. 3RT, Christie G5, Empire 7-1/2 valve extension box, or equal. Box covers on water lines shall be impressed with the letter "W". Gas line covers shall be impressed with the letter "G".

D. Stem Guides

1. Stem guides shall be of the adjustable wall bracket type, bronze bushed, with maximum spacing of 10 feet as manufactured by Clow, Rodney Hunt, or equal. Extended operating stems shall have universal joints and pin couplings if longer than 10 feet and a rating of at least five times the maximum operating torque.

PART 3 - EXECUTION

3.1 GENERAL

- A. Installation shall be as specified herein. Valve operators shall be located so that they are readily accessible for operation and maintenance. Valve operators shall be mounted for unobstructed access, but mounting shall not obstruct walkways. Valve operators shall not be mounted where shock or vibration will impair their operation. Support systems shall not be attached to handrails, process piping, or mechanical equipment.

3.2 OPERATORS

- A. General:
 - 1. Valves and gates shall be provided with manual operators, unless specified otherwise. Where possible, manual operators shall be located between 48" and 60" above the floor or a permanent work platform.
- B. Wrench Nuts:
 - 1. Wrench nuts shall be provided on buried valves, on valves which are to be operated through floor boxes, and where specified. Extended wrench nuts shall be provided if necessary so that the nut will be within 6" of the valve box cover.

3.3 OPERATOR APPURTENANCES

- A. Valve Boxes:
 - 1. Valve boxes extending to finished surfaces shall be provided for buried valves.
- B. Floor Boxes:
 - 1. Floor boxes shall be provided for wrench operation of valves located below concrete slabs. Each floor box and cover shall be of the depth required for installation in the slab.

END OF SECTION

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SECTION 40 05 57.23

POWERED VALVE OPERATORS AND OPERATOR APPURTENANCES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Powered operators for valves and operator appurtenances.
- B. Electric Actuator Schedule

Valve or Gate					Actuator			
Location	Type	Size, Inches	Service	Operating Press., PSI	Type ⁽¹⁾	Tag No.	Hazardous Area	Dwg Ref
Filter 1	BFV	36"	Filter Influent	25	EMTI	V3010	No	M302
Filter 1	BFV	30"	Backwash	25	EMTI	V3011	No	M305
Filter 1	BFV	14"	Air Wash	25	EMTI	V3012	No	M305
Filter 1	BFV	36"	Wash Water Drain	25	EMTI	V3013	No	M305
Filter 1	BFV	18"	Filter Effluent	25	EMTI	V3014	No	M305
Filter 1	BFV	18"	Filter Effluent	25	EMTI	V3015	No	M305
Filter 2	BFV	36"	Filter Influent	25	EMTI	V3020	No	M302
Filter 2	BFV	30"	Backwash	25	EMTI	V3021	No	M305
Filter 2	BFV	14"	Air Wash	25	EMTI	V3022	No	M305
Filter 2	BFV	36"	Wash Water Drain	25	EMTI	V3023	No	M305
Filter 2	BFV	18"	Filter Effluent	25	EMTI	V3024	No	M305
Filter 2	BFV	18"	Filter Effluent	25	EMTI	V3025	No	M305
Filter 3	BFV	36"	Filter Influent	25	EMTI	V3030	No	M302
Filter 3	BFV	30"	Backwash	25	EMTI	V3031	No	M305
Filter 3	BFV	14"	Air Wash	25	EMTI	V3032	No	M305
Filter 3	BFV	36"	Wash Water Drain	25	EMTI	V3033	No	M305
Filter 3	BFV	18"	Filter Effluent	25	EMTI	V3034	No	M305
Filter 3	BFV	18"	Filter Effluent	25	EMTI	V3035	No	M305
Filter 4	BFV	36"	Filter Influent	25	EMTI	V3040	No	M302
Filter 4	BFV	30"	Backwash	25	EMTI	V3041	No	M305
Filter 4	BFV	14"	Air Wash	25	EMTI	V3042	No	M305
Filter 4	BFV	36"	Wash Water Drain	25	EMTI	V3043	No	M305
Filter 4	BFV	18"	Filter Effluent	25	EMTI	V3044	No	M305
Filter 4	BFV	18"	Filter Effluent	25	EMTI	V3045	No	M305
Filter 5	BFV	36"	Filter Influent	25	EMTI	V3050	No	M302
Filter 5	BFV	30"	Backwash	25	EMTI	V3051	No	M305
Filter 5	BFV	14"	Air Wash	25	EMTI	V3052	No	M305

Valve or Gate					Actuator			
Location	Type	Size, Inches	Service	Operating Press., PSI	Type ⁽¹⁾	Tag No.	Hazardous Area	Dwg Ref
Filter 5	BFV	36"	Wash Water Drain	25	EMTI	V3053	No	M305
Filter 5	BFV	18"	Filter Effluent	25	EMTI	V3054	No	M305
Filter 5	BFV	18"	Filter Effluent	25	EMTI	V3055	No	M305
Filter 6	BFV	36"	Filter Influent	25	EMTI	V3060	No	M302
Filter 6	BFV	30"	Backwash	25	EMTI	V3061	No	M305
Filter 6	BFV	14"	Air Wash	25	EMTI	V3062	No	M305
Filter 6	BFV	36"	Wash Water Drain	25	EMTI	V3063	No	M305
Filter 6	BFV	18"	Filter Effluent	25	EMTI	V3064	No	M305
Filter 6	BFV	18"	Filter Effluent	25	EMTI	V3065	No	M305

⁽¹⁾ See Paragraph 3.04

1.2 REFERENCED SECTIONS

- A. The following Sections are referenced in this Section
1. Section 01660 – Product Requirements
 2. Section 01 78 23 – Operation Maintenance and Information
 3. Section 01785 – Warranties and Bonds
 4. Section 01820 – Training
 5. Section 01 81 00 – Equipment and System Testing, Start-up and Demonstration
 6. Section 01 99 00 – Reference Forms
 7. Section 46 05 13 – General Requirements for Equipment
 8. Section 11060 – Electric Motors

1.3 DEFINITIONS

- A. For use in control valve schedules in other sections and in this section, powered operators are defined as follows:

Operator (OPSPEC) Type	Service	Definition
EMTI	Isolating	Electric motor multi-turn
EMTT	Throttling	Electric motor multi-turn
EQTI	Isolating	Electric motor quarter-turn
EQTT	Throttling	Electric motor quarter-turn

1.4 SUBMITTALS

- A. Include the following items:
1. Electrical power and control wiring diagrams for electric motor operators marked to show specific changes necessary for the supplied equipment. If no changes are required, the drawing shall be marked "No Changes Required."

2. Manufacturer's catalog information and other data confirming conformance to design and material requirements.
3. Operating and maintenance information specified in Section 01 78 23.

1.5 QUALITY ASSURANCE

A. Unit Responsibility

1. Assign unit responsibility, as specified in Section 46 05 13, for equipment, accessories and appurtenances specified in this Section to the powered operator manufacturer. Extend this responsibility to include the valve associated with the operator.

B. ISO 9001 Quality System

1. Submit documentation of compliance prepared by independent certification agency approved by International Organization for Standardization.
2. Do not ship equipment before compliance documentation review has been completed.

1.6 PRODUCT SHIPMENT, PROTECTION, AND STORAGE

- A. Comply with Section 01660.

1.7 WARRANTY

- A. Comply with Section 01785.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. One of the following:

1. EIM Bettis XTE3000 series

B. Modify equipment, if necessary, to comply with this Section.

2.2 COMPONENTS

A. General

1. Size operators to produce an operating torque equal to 1.5 the maximum required valve operating torque under the specified flow conditions.
2. Factory-mount on the valve and provide as a unit.
3. On each valve body or operator cast the word "OPEN", an arrow indicating the direction to open, and flow direction arrows.
4. Specific requirements for each type of powered operator are specified in OPSPEC sheets at the end of this Section.

B. Motor

1. Design specifically for valve actuator service and be of totally enclosed, non-ventilated construction.
2. Suitable for use with 460V, three phase, 60 Hz power.
3. Rate for 15-minute duty and provide with NEMA Class F insulation.
4. Embed thermostat for thermal protection in the motor windings.

5. Minimum Size: As sized by the manufacturer for valve type and service conditions specified, but not more than the size listed in the Electric Actuator Schedule.
 6. Motors for throttling (modulating) service shall be designed for 1200 start-per-hour (S4, Class C).
- C. Enclosures
1. Rate motor and all electrical enclosures for NEMA 6/IP68.
 2. In hazardous areas, rate enclosures for both NEMA 6/IP68 and NEMA 7 Class 1 Div 1 Groups C and D.
 3. Enclosure standard: double o-ring sealed to prevent moisture ingress through conduit entry.
 4. Local control knobs shall not penetrate actuator housing.
 5. Provide space heaters as specified in Section 11060, Par. 2.05.L.
- D. Motor Starter
1. Provide with a three-phase full Voltage reversing starter with overload elements in each of the three poles.
- E. Gearing
1. Totally enclose the actuator gearing in an oil-filled gearcase suitable for operation at any angle.
 2. Manufacture all drive gearing and components of metal and incorporate a lost-motion hammer-blow feature.
 3. For rising spindle valves provide a hollow output shaft to accept a rising stem, and incorporate ball or roller thrust bearings at the base of the actuator.
 4. Design to permit the opening of the gearcase for inspection or disassembly without releasing the stem thrust or taking the valve out of service.
- F. Torque Switch
1. Use solid-state non-contacting electronic means capable of displaying torque percentage on local LCD display.
 2. Set point to be determined by valve manufacturer.
 3. Permit settings, adjustments, calibration, diagnostics, and data log file extraction to be accomplished without opening any electrical compartment.
 4. Provide PC/PDA compatible software to allow the Owner to perform diagnostics, save operational history and save torque profiles.
- G. Manual Operator
1. Provide with a handwheel for manual operation.
 2. Design so handwheel does not rotate during motor operation and so a locked motor or locked gearing does not prevent manual operation.
 3. For rising stem valves and gates, do not share any gearing with the motor.
 4. Provide motor or manual selection using a positive lockable declutching lever which will disengage the motor and motor gearing mechanically but not electrically. Plastic declutch levers are not acceptable.
 5. Design to prevent simultaneous operation in manual and motor modes.
 6. Design to limit rim effort to 80 lbs of rim effort at maximum torque.

- H. Hammer Blow Device
 - 1. Provide with a built-in lost-motion device that allows sufficient travel of the worm gear, prior to engaging the stem nut, for the motor to reach full speed.
 - 2. Through this action, impart a “hammer blow” to start the valve in motion in either direction.
 - 3. Share load equally by two lugs cast integrally on the drive sleeve.
 - 4. Delete hammer blow feature from modulating duty operators.
- I. Position Sensing and Remote Indication
 - 1. Sense position without the use of switches via an absolute encoder with no more than four moving parts which has built in redundancy should one of the four parts fail in any way or a similar device. Display position on the LCD as open limit, closed limit, or 1-99% open in 1/10% increments.
 - 2. Provide four software configurable (expandable to twelve) indication contacts as shown in the OPSPEC sheets.
 - 3. Local position display and indication contacts shall update even during loss of main power. External control power shall not be necessary to achieve this.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General
 - 1. Locate operators so that they are readily accessible for operation and maintenance.
 - 2. Mount for unobstructed access, but do not obstruct walkways.
 - 3. Do not mount where shock or vibration will impair operation.
 - 4. Do not attach support systems to handrails, process piping, or mechanical equipment.
 - 5. Locate manual operating accessory, where possible, between 48” and 60” above the floor or a permanent work platform.
- B. Identification Tags
 - 1. Provide each powered operator with a 16-gage stainless steel identification tag.
 - 2. Inscribe complete equipment number of the operator.
 - 3. Characters: 1/4”, die-stamped.
 - 4. Securely attach to the operator in a readily visible location using stainless steel screws or wire.
- C. Electrical Power and Signal Wiring and Equipment
 - 1. Comply with Division 16.

3.2 MANUFACTURER’S FIELD SERVICES

- A. Provide field inspection and instruction services by factory-trained service technician of the manufacturer as specified in **Section 01820 and Section 01 81 00**. Services by a sales representative are not acceptable.
 - 1. Provide minimum one (1) visit of 8 hours, excluding travel time, to inspect and test initial operation, and make necessary adjustments.

2. Provide minimum one (1) visit of 8 hours, excluding travel time, to train plant operators.
 3. Include one follow up training and troubleshooting session as specified in Section 01820.
- B. Complete and submit the following forms in Section 01 99 00:
1. Manufacturers Installation Certificate Form
 2. Manufacturers Instruction Certificate Form

3.3 DEMONSTRATION

- A. Comply with Section 01 81 00.

3.4 OPERATOR SPECIFICATION (OPSPEC) SHEETS

- A. The following OPSPEC sheets are included in this section: EMTI, EMTT, EQTI, EQTT.

Operator Type	EMTI
Description:	Electric Multi-turn Isolation valve operator
Construction:	Rotork IQ or Limitorque Accutronix MX, modified as necessary to provide the specified features and to meet the specified operating requirements. Where specified in the Electric Actuator Schedule, provide Rotork IQ with IW gearbox and Limitorque Accutronix MX with HBC gearbox
Controller:	Phase detecting combination starter in compliance with NEMA ICS, correcting backwards phase landing for motor protection.
Controls:	<ol style="list-style-type: none"> 1. Control power: Provide by an integral 120 Volts AC, single-phase control transformer unless a separate power source is shown on the electrical drawings. 2. Size transformer to operate at not more than 80% of rating with the connected load shown: Include protective secondary fusing. 3. Provide with an integral control station. <ol style="list-style-type: none"> a. Include "Local/Stop/Remote" toggle switch and "Open/Close" toggle switch. "Local/Stop/Remote" shall accept standard 1/4" padlock to lock in either position. b. Momentary operation of the "OPEN" or "CLOSE" toggle: Causes the operator to drive the valve or gate to the appropriate limit. Software configuration shall allow push-to-run operation where desirable. c. Momentary operation of the "STOP" pushbutton: Causes the operator to stop. d. Provide terminals for remote "OPEN" and "CLOSE" pushbuttons.

Operator Type	EMTI
Remote Valve Position/ Actuator Status indication:	<ol style="list-style-type: none"> 1. Provide four contacts (expandable to twelve) which can be selected to indicate any position of the valve or gate. <ol style="list-style-type: none"> a. Provide for the selection of a normally closed or open contact form. b. Maintain and update position indication during handwheel operation when all external power to the actuator is isolated. c. Rate at 5A, 120V AC, 30V DC. 2. As an alternative to providing valve position, configure so any of the four above contacts may be selected to signal one of the following: <ol style="list-style-type: none"> a. Valve opening, closing or moving b. Thermostat tripped, lost phase c. Motor tripped on torque in mid travel, motor stalled d. Remote selected e. Actuator being operated by handwheel

Operator Type	EMTT
Description:	Electric Multi-Turn Throttling valve operator
Construction:	Rotork IQM or Limatorque Accutronix MX with SSMR, modified as necessary to provide the specified features and to meet the specified operating requirements.
Controller:	<ol style="list-style-type: none"> 1. Provide solid-state electronic, servo-amplifier comparator and a solid state thyristor starting circuit with dynamic braking capability. 2. Accept an external 4 to 20 mA DC isolated position input signal into a maximum load of 250 ohms. 3. Generate a position feedback signal off the indication of an absolute encoder with no more than four moving parts which has built in redundancy should one of the four parts fail in any way. 4. Compare the input signal with the feedback signal to produce an error signal. 5. Cause the motor to move the valve or gate in a direction so as to reduce the magnitude of the error signal. 6. Positioning accuracy: Plus or minus 1/10% of travel or better. 7. Operating speeds: 12 in/min for linear operators and 180° per minute for rotary operators. 8. Produce a 4 to 20 mA DC isolated position feedback signal which shall be directly proportional, and field reversible, to the position of the valves or gates. 9. Equivalent to Rotork Type IQM.
Controls:	<ol style="list-style-type: none"> 1. Control power: Provide by an integral 120 volts AC, single-phase control transformer unless a separate power source is shown on the electrical drawings. 2. Size transformer to operate at not more than 80% of rating with the connected load shown: Include protective secondary fusing. 3. Provide with an integral control station. <ol style="list-style-type: none"> a. Include "Local/Stop/Remote" toggle switch and "Open/Close" toggle switch. "Local/Stop/Remote" shall accept standard 1/4" padlock to lock in either position. b. Momentary operation of the "OPEN" or "CLOSE" toggle: Causes the operator to drive the valve or gate to the appropriate limit. Software configuration shall allow push-to-run operation where desirable. c. Momentary operation of the "STOP" pushbutton: Causes the operator to stop. d. Provide terminals for remote "OPEN" and "CLOSE" pushbuttons.

Operator Type	EQTI
Description	Electric Quarter-turn Isolation valve operator
Construction	Rotork IQT or Limitorque Accutronix MX with HBC gearbox, modified to meet the requirements specified in this section.
Gear box	90° gear operator.
Controller	Non-fused disconnect type combination starter in compliance with NEMA ICS.
Controls	<ol style="list-style-type: none"> 1. Control power: Provide by an integral 120 volts AC, single-phase control transformer unless a separate power source is shown on the electrical drawings. 2. Size transformer to operate at not more than 80% of rating with the connected load shown: Include protective secondary fusing. 3. Provide with an integral control station. <ol style="list-style-type: none"> a. Include "Local/Stop/Remote" toggle switch and "Open/Close" toggle switch. "Local/Stop/Remote" shall accept standard 1/4" padlock to lock in either position. b. Momentary operation of the "OPEN" or "CLOSE" toggle: Causes the operator to drive the valve or gate to the appropriate limit. Software configuration shall allow push-to-run operation where desirable. c. Momentary operation of the "STOP" pushbutton: Causes the operator to stop. d. Provide terminals for remote "OPEN" and "CLOSE" pushbuttons.
Remote Valve Position/ Actuator Status indication:	<ol style="list-style-type: none"> 1. Provide four contacts (expandable to twelve) which can be selected to indicate any position of the valve or gate. <ol style="list-style-type: none"> a. Provide for the selection of a normally closed or open contact form. b. Maintain and update position indication during handwheel operation when all external power to the actuator is isolated. c. Rate at 5A, 120V AC, 30V DC. 2. As an alternative to providing valve position, configure so any of the four above contacts may be selected to signal one of the following: <ol style="list-style-type: none"> a. Valve opening, closing or moving b. Thermostat tripped, lost phase c. Motor tripped on torque in mid travel, motor stalled d. Remote selected e. Actuator being operated by handwheel <input type="checkbox"/>

Operator Type	EQTT
Description	Electric Quarter-Turn Throttling valve operator
Construction	Rotork IQTM or Limatorque Accutronix MX with HBC gearbox and SSMR, modified to meet the requirements specified in this section.
Gear box	90° gear operator.
Controller	<ol style="list-style-type: none"> 1. Provide a solid-state electronic, servo-amplifier comparator and a solid state Triac starting circuit. 2. Accept an external 4- to 20-mA DC isolated position input signal into a maximum load of 250 ohms. 3. Generate a position feedback signal off the indication of an absolute encoder with no more than four moving parts which has built in redundancy should one of the four parts fail in any way 4. Compare the input signal with the feedback signal to produce an error signal. 5. Cause the motor to move the valve or gate in a direction so as to reduce the magnitude of the error signal. 6. Positioning accuracy: Plus or minus 1/10% of travel or better. 7. Operating speeds: 12 in/min for linear operators and 180° per minute for rotary operators. 8. Equivalent to Rotork IQTM.
Controls	<ol style="list-style-type: none"> 1. Control power: Provide by an integral 120 volts AC, single-phase control transformer unless a separate power source is shown on the electrical drawings. 2. Size transformer to operate at not more than 80% of rating with the connected load shown: Include protective secondary fusing. 3. Provide with an integral control station. <ol style="list-style-type: none"> a. Include “Local/Stop/Remote” toggle switch and “Open/Close” toggle switch. “Local/Stop/Remote” shall accept standard 1/4” padlock to lock in either position. b. Momentary operation of the “OPEN” or “CLOSE” toggle: Causes the operator to drive the valve or gate to the appropriate limit. Software configuration shall allow push-to-run operation where desirable. c. Momentary operation of the “STOP” pushbutton: Causes the operator to stop. d. Provide terminals for remote “OPEN” and “CLOSE” pushbuttons.

END OF SECTION

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SECTION 40 05 60
VALVES AND APPURTENANCES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Furnish and install valves and appurtenances as shown on the Drawings and described in the Specifications, as required to interconnect with equipment and piping for a complete and operable system.

1.2 REFERENCED SECTIONS

- A. The following Sections are referenced in this Section:
 - 1. Section 01 78 23 – Operation and Maintenance Information
 - 2. Section 09 96 00 – High Performance Coating
 - 3. Section 10 14 13 – Piping and Valve Identification Systems
 - 4. Section 40 05 57.13 – Manual Valve and Gate Operators and Accessories
 - 5. Section 40 05 57.23 – Powered Valve Operators and Operator Appurtenances
 - 6. Section 40 71 00 – Flow Measurement
 - 7. Division 40 – Process Interconnections

1.3 REFERENCES

- A. ANSI – American National Standards Institute
- B. ASTM – American Society for Testing and Materials
- C. AASHTO – American Association of State Highway Transportation Officials
- D. AWWA – American Water Works Association
- E. NSF – National Sanitation Foundation

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. Manufacturer's catalog information including product data, details of construction and materials list.
 - 2. Shop drawings showing dimensions, cross-sectional view and weight
 - 3. Data: Submit test reports certifying that manufacturer has performed adequate testing prior to shipment on site.
 - 4. Operation and Maintenance Data: Submit in accordance with Section 01 78 23.
- B. Protective Coatings: Manufacturer's data
- C. A schedule of valves indicating the label location, attachment method, and proposed label text for each valve.
- D. Certifications:
 - 1. Submit certifications to demonstrate compliance with Paragraph 2.01.A (e.g., NSF 61 certification). Quality Assurance

1.5 QUALITY ASSURANCE

- A. Factory test one valve of each type supplied for a particular service for valves of diameter less than 4”.
- B. Test steel-bodied valves hydrostatically per ANSI B16.5
- C. Test aluminum-, bronze- and brass-bodied valves hydrostatically at double the maximum pressure specified.
- D. Leakage, sweating or visible deformation at any point on the valve is cause for rejection of valves of that type and manufacturer.
- E. Submit a certified copy of the pressure test reports for all valves over 12 inches in nominal size prior to shipping valves to the site. Format these test press er the requirements of the applicable reference standards.
- F. For gate valves, demonstrate Compliance with Referenced Standard:
 - 1. Testing records per Section 5 of AWWA C509.
 - 2. Affidavit of compliance with AWWA C509.

1.6 STORAGE AND PREPARATION FOR INSTALLATION

- A. Package and store valves to prevent exposure to sunlight, chemical exposure, and atmospheric pollution.
- B. Inspect each valve prior to installation for damage. Repair any damage to seats, machined surfaces, or protective coatings before installation. Clean each valve to remove any dirt and debris from the interior surfaces and seat areas. Install valves in the closed position.
- C. Some valves must be installed with seats or seat adjustment rings on the downstream side of the valve. Determine these requirements prior to installation and install the valve in the correct orientation.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. All valves of each type shall be the product of one manufacturer.
- B. Valves shall be complete with all necessary operating hand wheels, chain wheels, extension stems, valve boxes, floor stands, worm and gear operators, operating nuts, chains, hardware and fasteners, and wrenches which are required for the proper completion of the work included under this section.
- C. Valves shall be furnished full line size unless specifically called out to be of reduced size. Unless otherwise specified, valves shall be rated for 150 psi working pressure minimum.
- D. All exposed valves shall be furnished with operators, handwheels, levers, or other suitable type wrench including handles as specified herein or as shown on the Drawings.
- E. Valves 4-inch and larger located more than 7 feet above the floor level shall be furnished with chain operators. Chains shall be galvanized and shall extend to within 3 feet of the floor. Provide hook so that chain may be stored clear of walkways. All buried valves shall be provided with 2-inch-square operating nut and valve boxes.
- F. For all buried valves provide valve boxes and extended stems to within 6 inches of finished grade.
- G. Unless otherwise indicated, the direction of rotation of the wheel, wrench nut or lever to open the valve shall be counterclockwise.

- H. All exposed valves and valve operators shall have a non-bleeding shop coat, unless otherwise specified.
- I. All materials in contact with the potable water, process water to be treated to potable water, or liquids (e.g., chemicals) to be added to the process/potable water shall be lead-free and shall meet the requirements of California Code of Regulations Title 22 Chapter 16 Article 7 regarding direct and indirect additives.
- J. Unless otherwise specified, all interior bronze parts of valves shall conform to the requirements of ASTM B62.
- K. Wetted parts shall be lead-free as defined by Oregon Health Authority, US EPA, or the most stringent of current regulations.

2.2 BUTTERFLY VALVES

- A. Manufacturers
 - 1. Pratt, 2FII or XR70;
 - 2. Crispin, K-Flo;
 - 3. DeZurik BAW;
 - 4. Or equal.
- B. Design
 - 1. Manufactured in accordance with AWWA C504, except where otherwise specified herein.
 - 2. Pressure Class: 150B.
 - 3. Type: Short body flanged.
 - 4. Disc: Lens-shaped design.
 - 5. Seats: One-piece construction, molded and bonded into the recessed cavity of the valve body. Cartridge type seats with retaining rings are not acceptable.
- C. Valve Diameter: Internal diameter of valve at the throat shall be no less than the nominal diameter of the valve less 1-1/2 inches.
- D. Materials
 - 1. Shaft: Stainless steel, ASTM A276, Type 304.
 - 2. Disc: Ductile iron, ASTM A536; or cast iron, ASTM A48, Class 40; or cast iron, ASTM A126, Class B; or stainless steel, ASTM A276, Type 316.
 - 3. Disc Edge: Stainless steel, ASTM A276, Type 316.
 - 4. Seat: Buna-N.
 - 5. Body: Cast iron, ASTM A126, Class B.
- E. Finish
 - 1. Exposed Exterior: Shop prime compatible with field applied finish coats. Refer to Section 09 96 00.
 - 2. Buried Exterior: Shop coat with high-solids epoxy, 12 mils minimum.
 - 3. Interior: Shop line with two-component, high solids epoxy, AWWA C550.

2.3 RESILIENT SEATED GATE VALVES

A. General Requirements:

1. Use resilient seated type gate valves for valves 3-inches in nominal size and larger.
2. Pressure Ratings:
 - a. Valves less than 16 inches in nominal size: 200 psi.
 - b. Valves 16-inch and larger: 150 psi.
3. Type:
 - a. Exposed Gate Valves: Rising stem type with stem yoke.
 - b. Buried Gate Valves: Non-rising stem type.

B. Manufacturers: One of the following, or equal:

1. American Darling
2. M&H / Kennedy Valve Company, Model KS-RW.
3. Clow Corporation
4. Mueller Company, 2360 Series.
5. AVK

C. Valve Design:

1. Body, Bonnet, and Wedge: Cast iron conforming to ASTM A126, Class B.
2. Wedge: Fully encapsulated with SBR rubber conforming to ASTM D5000 and meeting rubber-to-metal bond tests specified in ASTM D249.
3. End Connections: Unless otherwise indicated on the Drawings, provide valves with the following end connections:
 - a. Exposed Gate Valves: Flanged ends conforming to ANSI B16.5.
 - b. Buried Gate Valves: Mechanical joint or push-on ends.
4. Stem: Cast bronze with integral collars.
5. Stem Packing:
 - a. Rising stem valves: Teflon braid packing in a stuffing box.
 - b. Non-rising stem valves: Provide with double or triple o-ring stem seals or with braided packing material.
6. Operator Extension: As indicated on the Drawings.

D. Valve Actuator:

1. Exposed Gate Valves: Provide valve with manual handwheel actuator unless a powered actuator is indicated on the Drawings.
 - a. Valves 8-inch in Nominal Size and Larger: Provide geared type actuator.
2. Buried Gate Valves: AWWA operating nut on a shaft that extends to within 6 inches below finished grade. Support shaft at 5 foot intervals with the last support just below the operating nut. Provide 42-inch long operating wrench.
3. Operation: Counter clock-wise to open.

E. Coating:

1. Coat interior and exterior of valve body and bonnet with fusion bonded epoxy.
 - a. Fusion bonded epoxy: Complying with AWWA C550 and NSF/ANSI 61 approved.

2.4 METAL SEATED GATE VALVES

- A. Use metal seated type gate valves for valves less than 3-inches in nominal size.
- B. Gate Valves Smaller than 3 inches in Nominal Size:
 - 1. Non-rising stem type valve with bronze body, solids wedge disc, screw-in bonnet with PTFE packing.
 - 2. Pressure Rating: 125 psi.
 - 3. Valve Ends: Threaded in accordance with ASME B1.20.1.
 - 4. Coating: Standard factory finish.
- C. Manufacturers: One of the following or equal:
 - 1. Crane Company 1700 Series.
 - 2. Jenkins, Figure 47.
 - 3. Mueller H10914.

2.5 BALL VALVES

- A. Bronze: Two piece regular port
 - 1. Rating: 600 psi CWP
 - 2. Type: Lever.
 - 3. Connections: Threaded.
 - 4. Materials: Lead-free Bronze body, Zinc-plated steel lever nut, lead free brass stem, RPTFE seat, lead free brass ball, chrome plated, stem packing MPTFE, steel lever, zin-plated with vinyl grit
 - 5. Manufacturers: Apollo 70LF-100 or equal.
- B. PVC: full port Tru union type
 - 1. Rating: 250 psi
 - 2. Type: Handle
 - 3. Connections: Threaded or socket
 - 4. Materials: PVC or CPVC Body, FPM or EDPM Seal, Teflon seat, double o-ring stem seal.
 - 5. Installation: Use suitable solvent weld products
 - 6. Manufacturer: Hayward TBH series or equal

2.6 DIAPHRAGM VALVES

- A. Manufacturers
 - 1. Chemtrol Series PD
 - 2. Posacon 677
 - 3. Or equal
- B. Design
 - 1. PVC body with EPDM or Teflon diaphragm

2.7 SWING CHECK VALVE

- A. Manufacturers
 - 1. Dezurik/Apco Series 6000
 - 2. Equivalent by Golden Anderson
 - 3. Or equal.
- B. Design
 - 1. Full waterway, self-aligning disc
 - 2. Pressure Rating: 250 CWP psi
 - 3. Connections: Flanged, 125-pound ANSI.
 - 4. Lever and weight closure control
- C. Materials: Ductile iron body and cover, ductile iron disk, stainless steel pivot shafts, stainless steel trim

2.8 AIR RELEASE VALVE – CLEAN WATER

- A. Manufacturers
 - 1. Dezurik;
 - 2. Equivalent by Valmatic;
 - 3. Or equal.
- B. Design
 - 1. Function: Releases accumulated air under pressure at pipeline high points.
 - 2. Pressure Rating: 150 psi
 - 3. Body style 200 with compound lever.
- C. Materials: Cast or ductile iron body; stainless steel float, needle and linkage, Buna-N seat

2.9 COMBINATION AIR RELEASE/AIR VACUUM VALVE – WASTEWATER – (2")

- A. Manufacturers
 - 1. Dezurik Series 145C
 - 2. Equivalent by Valmatic
 - 3. Or equal
- B. Design:
 - 1. Releases accumulated air under pressure at pipeline high point.
 - 2. Single body, NPT output, double orifice
 - 3. Pressure rating: 150 psi
- C. Materials: Cast or ductile iron body, stainless steel float. Standard epoxy coated
- D. Mushroom cap for outlet

2.10 COMBINATION AIR RELEASE/AIR VACUUM VALVE – WASTEWATER – (4")

- A. Manufacturers
 - 1. APCO 1800
 - 2. Valmatic 48A/304

3. Or equal
- B. Design:
 1. Type: Dual body
 2. Inlet/Outlet: Flanged unless otherwise indicated
 3. Releases accumulated air under pressure at pipeline high point.
 4. Single body, NPT output, double orifice
 5. Pressure rating: 150 psi
- C. Materials: Cast or ductile iron body, stainless steel float. Standard epoxy coated
- D. Mushroom cap for outlet

2.11 ECCENTRIC PLUG VALVES

- A. General
 1. Description: Non-lubricated, eccentric plug-type valve.
 2. Suitable for drip-tight, bi-directional shutoff at the specified valve design pressure.
- B. Valve Design
 1. Port Design
 - a. Rectangular shaped.
 - b. Port Area:
 - 1) Valves less than or equal to 20-inches in nominal size: At least 80 percent of the full pipe cross-sectional area.
 - 2) Valves greater than 20-inches in nominal size: At least 70 percent of the full pipe cross-sectional area.
 2. Plug Design:
 - a. Geometry: Eccentrically shaped with a cylindrical seating surface that is offset from the center of the plug shaft.
 - b. Facing:
 - 1) Encapsulate entire plug with resilient material.
 - 2) Bond between Resilient Facing and Metal Plug: Capable of withstanding 75-pound pull in accordance with ASTM D429, Method B.
 3. Valve Seats: Welded-in overlay of not less than 90 percent pure nickel to form a raised area at least 1/8-inch thick for contact with the plug facing. Machine seat after welding to provide a smooth surface.
 4. Shaft Bearing and Bottom Bearing:
 - a. Provide replaceable bearings in the upper and lower shaft trunnions.
 - b. Design: Sleeve-type, permanently lubricated.
 5. Shaft Seal: Chevron type packing seal, held in place with an adjustable gland follower. Valves using O-ring type shaft seals are not acceptable.
- C. Valve Body Pressure Ratings
 1. Valves 12 inches in nominal size and smaller: 175 psi.
 2. Valves 14-inches through 36-inches in nominal size: 150 psi.
 3. Valves 42-inches through 54-inches in nominal size: 125 psi.

D. End Connections

1. Valves 3 inches and Smaller: Threaded ends.
2. Valves Larger than 3 inches:
 - a. Exposed Piping Systems: Flanged end connections with flange dimensions, facing and drilling conforming to ANSI B16.1, Class 125.
 - b. Buried Piping Systems: Mechanical joint end connections conforming to ANSI A21.11/AWWA C606.

E. Materials of Construction

1. Body: Cast iron, ASTM A126, Class B.
2. Plug: Cast iron, ASTM A126, Class B, or cast iron ASTM A436 (Ni-resist), or ductile iron, ASTM A536.
3. Plug Facing: Neoprene or Buna-N.
4. Body Seats:
 - a. Valves less than 3 inches in nominal size: Cast iron, ASTM A126, Class B.
 - b. Valves 3 inches in nominal size and larger: Stainless steel, ASTM A276, Type 304 or nickel.
5. Stem Packing: Buna-N or PTFE.
6. Plug Bearings: Type 316 stainless steel.
7. Bolts, Studs, Nuts and Washers: Zinc plated in exposed installations, Type 316 stainless steel in buried installations.

F. Shop Applied Interior and Exterior Coatings

1. Interior Surfaces: Apply two coats Ameron Amerlock 400, Kop Coat Carboline 890LT, or equal. Apply each coat to 4 to 5 mils thick.
2. Exterior Surfaces: Apply polyurethane coating system consisting of one coat primer, one intermediate coat of polyamide epoxy, and one final coat of polyurethane.
 - a. Primer and Intermediate Coats: Ameron Amerlock 400, Kop Coat Carboline 890LT, or equal. Apply each coat to 4 to 5 mils thick.
 - b. Finish Coat: Ameron Amercoat 450HS, Kop Coat Carboline 134HS, Tnemec Series 74 Semi-Gloss Endura-Shield, or equal. Apply 1.5 to 2 mills thick.

2.12 VALVE ACTUATORS

A. General

1. Furnish all valves with operators, handwheels, levers, or other suitable handles as shown on the Drawings or specified herein.
2. Furnish chain operators for valves 4-inches and larger located more than 7-feet above the floor. Provide a hook to store the chain clear of walkways.
3. Provide 2-inch-square operating nut for all buried valves. See Section 40 05 57.13 for additional valve operator appurtenances for buried valve.
4. All threaded stem valves shall open by turning the valve stem counter clock-wise.

2.13 PRESSURE GAUGE ASSEMBLY

- A. Complete installation, unless otherwise shown, shall include ¾-inch plug valve isolation at the main, a gauge protector made specifically for solids handling service, a snubber and gauge. Provide a support plate to the nearest flange.
- B. Plug Valve: Shall be DeZurik PEC; or equal. Connections shall be threaded
- C. Protector: Shall be for slurry service with flushing connection. Body shall be steel or cast iron. Diaphragm shall be removable of Type 316 stainless steel. Complete unit shall be Trerice, M & G (U.S. Gauge), or equal.
- D. Gauges and Snubbers: Shall be as specified for System A.
- E. Installation: All protectors and gauge bourdon tubes shall be evacuated of air, glycerin filled at the factory and factory calibrated.
- F. See Division 40 for additional instrumentation requirements, including installation, calibration, and testing requirements.
- G. Manual Valve Operators: See Section 40 05 57.13 for additional requirements.
- H. Powered Valve Operators: See Section 40 05 57.23 for motorized valve actuators.
 - 1. Wye Strainers
 - a. Materials
 - b. Connections: True union.
 - c. Strainer shall have hex cap for access to screen.
 - d. Supply with 1/2-inch brass gauge cock.

2.14 SAFETY EYEWASH AND SHOWER

- A. Type 1 - Standard
 - 1. SS-3 - Combination eyewash and shower safety station
 - a. Hand and foot control
 - b. Stainless steel shower head with internal 20 GPM flow control
 - c. Stainless steel eyewash bowl
 - d. Powder-coated cast aluminum flag handle and floor flange
 - e. Piping and fittings: 1¼" IPS Schedule 40 galvanized 1" IPS and ½" IPS domestic chrome-plated brass stay-open ball valves
 - f. Foot treadle and polished stainless steel pull rod.
 - g. Unit shall have (2) polypropylene GS-Plus™ spray heads with integral "flip-top" dust covers, filters, and 1.6 GPM flow control orifices mounted on a chrome-plated brass eyewash assembly.
 - h. Unit shall include ANSI compliant sign.
 - i. Flow switch per Section 40 71 00.
 - 2. Performance: Unit shall meet or exceed ANSI Z358.1 – 2014, and come with a full 2-year warranty.
 - 3. Supplier: Guardian Equipment G1902HFC and G1902HFC-SSH
- B. Type 1 - Freeze Protection
 - 1. SS-22* - Combination eyewash and shower safety station with freeze protection valve (activates at 35°F)
 - a. Stainless steel shower head with internal 20 GPM flow control
 - b. Stainless steel eyewash bowl

- c. Stainless steel flag handle,
 - d. Powder-coated cast aluminum floor flange
 - e. Piping and Fittings: 1¼" IPS Schedule 40 galvanized pipe and fittings, 1" IPS and ½" IPS domestic chrome-plated brass stay-open ball valves
 - f. Polished stainless steel pull rod
 - g. Unit shall have (2) polypropylene GS-Plus™ spray heads with integral "flip-top" dust covers, filters, and 1.6 GPM flow control orifices mounted on a chrome-plated brass eyewash assembly.
 - h. Unit shall include ANSI compliant sign.
 - i. Flow switch per Section 40 71 00.
- 2. Performance: Unit shall meet or exceed ANSI Z358.1 – 2014, and come with a full 2-year warranty.
 - 3. Supplier: Guardian Equipment G1941 and G1941SSH

PART 3 - PRODUCTS

3.1 INSTALLATION

- A. Install valves in accordance with the manufacturer's recommendations.
- B. Valves installed in vertical runs of pipe shall have their operating stems oriented to facilitate the most practicable operation, as approved by the Engineer.
- C. Install butterfly valves in accordance with the manufacturer's published recommendations and AWWA C504.
- D. Provide valve tags for valve identification. See Section 10 14 13.

3.2 TESTING

- A. Test valves at the same time that the adjacent pipeline is tested.
- B. Joints shall show no visible leakage under test. Joints that show signs of leakage shall be repaired prior to final acceptance.
- C. Protect any special parts of control systems or operators that might be damaged by the pipeline test. The Contractor shall be held responsible for any damage caused by the testing.
- D. If requested by the City, the valve manufacturer shall furnish an affidavit stating the materials options furnished, and/or that these and other referenced specifications have been complied with.

3.3 FIELD PAINTING

- A. Paint exposed valves in accordance with Section 09 96 00.
- B. Coat all buried metal parts such as valves and bolt-ups not cement mortar coated with two coats of bitumastic in accordance with Section 09 96 00 and encased with one sheet of 8 mil minimum thickness polyethylene to form a continuous and all-encompassing layer of polyethylene between the protected metal and surrounding earth.
- C. Secure all polyethylene in place with 10-mil polyethylene tape.

END OF SECTION

SECTION 40 05 96
SEISMIC RESTRAINTS FOR PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Seismic restraints for bracing all piping systems specified in Section 40 05 10.

1.2 REFERENCED SECTIONS

- A. The following Sections are referenced in this Section
 - 1. Section 01 61 10 – Seismic Design Requirements
 - 2. Section 01 61 11 – Seismic Anchorage and Bracing
 - 3. Section 05 50 01 – Anchor Bolts and Anchoring Devices
 - 4. Section 40 05 07 – Pipe Hangers and Supports
 - 5. Section 40 05 10 – Piping Systems

1.3 DEFINITIONS

- A. Longitudinal Direction: Direction parallel to the pipe axis.
- B. Lateral Direction: Direction perpendicular to the pipe axis.

1.4 OPERATING CONDITIONS

- A. Provide seismic restraints, specified in this section, to resist pipe movements and loads occurring as a result of an earthquake or other seismic event.
- B. Unless otherwise specified, brace all piping to resist seismic loading caused by forces applied at the individual pipe's center of gravity. For seismic loading see Section 01 61 10.

1.5 RESTRAINT SELECTION

- A. Unless otherwise specified, select, locate and provide seismic restraints for piping in accordance with the contract documents.
- B. Review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the restraint to be used at each point.
- C. Seismic restraints may be omitted from the following installations:
 - 1. All other piping less than 2-1/2" inside diameter.
 - 2. All piping suspended by individual hangers 12" or less in length from the top of the pipe to the bottom of the support for the hanger.
- D. Do not brace piping systems to dissimilar parts of a building or to dissimilar building systems that may respond in a different mode during an earthquake. Examples: wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.
- E. Size restraints to fit the outside diameter of the pipe, tubing, or, where specified, the outside diameter of insulation.
- F. Do not permit contact between a pipe and restraint component of dissimilar metals. Prevent contact between dissimilar metals when restraining copper tubing by the use of copper-plated, rubber, plastic or vinyl coated, or stainless steel restraint components.
- G. Do not use branch lines to brace main lines.

- H. Do not permit seismic bracing to limit the expansion and contraction of the piping system.

1.6 SUBMITTALS

- A. Provide seismic restraint locations, load calculations, and manufacturer's drawings as specified in Paragraph 3.01 as part of the submittals for equipment and piping coordination and installation drawings required in Section 40 05 10.
- B. Provide seismic restraint load calculations for each seismically restrained pipe system prepared and signed by a civil or structural engineer currently registered in the State of California. See Section 01 61 11 for seismic loading required.

PART 2 - MANUFACTURERS

2.1 MANUFACTURERS

- A. Carpenter & Patterson.
- B. B-Line.
- C. Kin-Line.
- D. Anvil International.
- E. Michigan.
- F. Pipe Shields Incorporated.
- G. Superstrut.
- H. Unistrut.
- I. Or equal.

2.2 PRODUCTS

- A. Materials
 - 1. Restraints, including braces and fittings, pipe and structural attachments, trapeze restraints, and accessories: Type 316 stainless steel.
 - 2. Nuts, bolts and washers, fittings and accessories: Type 316 stainless steel.
 - 3. Comply with MSS SP-58
- B. Pipe Attachments
 - 1. Type 1s - Clevis Restraint Attachment
 - a. Provide Type 1, clevis pipe hanger, as specified in Section 40 05 07, 2.02.B.
 - 2. Type 3s - Double Bolt Restraint Clamp:
 - a. Provide Type 3, double bolt pipe clamp, as specified in Section 40 05 07, 2.02.B.
 - 3. Type 4s - Roller Restraint Attachment
 - a. Provide Type 4, adjustable roller hanger, as specified in Section 40 05 07, 2.02.B.
 - b. Size hold down strap as follows:
 - 1) 1" through 2" Pipe: 1" by 1/8" thick
 - 2) 2-1/2" through 4" Pipe: 1-1/4" by 3/16" thick
 - 3) 6" Pipe: 2" by 3/16" thick

- 4) 8" Pipe: 2-1/2" by 3/16" thick
 - 5) 10" through 16" Pipe: 2-1/2" by 1/4" thick
 - 6) 20" Pipe: 3" by 1/4" thick
 - 7) 24" Pipe: 3" by 3/8" thick.
- 4. Type 7s - U-Bolt Restraint
 - a. Provide Type 7, U-bolt, as specified in Paragraph 40 05 07, 2.02.B.
 - 5. Type 13s - Framing Channel Strap Restraint
 - a. Provide Type 13, framing channel pipe strap, as specified in Paragraph 40 05 07, 2.02.B.
 - 6. Type 14s - Pipe Clamp Restraint
 - a. Provide with configuration and components equivalent to MSS and FEDSPEC Type 4.
 - b. Rod attachment and longitudinal brace connection stud shall be fabricated and welded by the manufacturer.
 - c. Steel pipe (insulated): Superstrut No. S-720, Kin-Line No. S475, or equal, with insulation shield.
 - d. Steel pipe (uninsulated): Superstrut No. S-720, Kin-Line No. S475, or equal.
 - e. Cast and ductile iron pipe: Superstrut No. S-720, Kin-Line No. S475, or equal.
 - f. Copper pipe (insulated): Superstrut No. S-720, Kin-Line No. S475, or equal, with insulation shield.
 - g. Copper pipe (uninsulated): Superstrut No. S-720, Kin-Line No. S475, or equal, with insulation shield or dielectric lining.
 - h. Plastic pipe: Superstrut No. S-720, Kin-Line No. S475, or equal.
- C. Trapeze Restraints
- 1. General
 - a. Unless otherwise specified, provide trapeze members with a minimum steel thickness of 12-gage, with a maximum deflection 1/240 of the span.
 - 2. Type 20s - Single Channel Lateral Restraint
 - a. Trapeze restraint cross member
 - 1) 1-5/8" square framing channel, Unistrut P1000, B-Line B22, Superstrut A-1200, or equal.
 - b. Pipe attachments
 - 1) Type 13s or Type 7s specified in Paragraph 2.02.B.
 - c. Rod stiffeners and lateral brace
 - 1) As specified in Paragraph 2.02.D.
 - 3. Type 21s - Double Channel Lateral Restraint
 - a. Trapeze restraint cross member
 - 1) a double channel manufactured assembly such as Unistrut P1001, B-Line B22A, Superstrut A-1202, or equal.
 - 2) Pipe attachments
 - a) Type 13s or Type 7s specified in Paragraph 2.02.B.
 - b. Rod stiffeners and lateral brace
 - 1) As specified in Paragraph 2.02.D.

4. Type 22s - Double Channel Longitudinal Restraint
 - a. Trapeze restraint cross member: a double channel manufactured assembly such as Unistrut P1001, B-Line B22A, Superstrut A-1202, or equal.
 - b. Pipe attachments
 - 1) Type 13s or Type 7s specified in Paragraph 2.02.B.
 - c. Rod stiffeners, longitudinal and lateral braces
 - 1) As specified in Paragraph 2.02.D.
- D. Braces and Fittings
1. Seismic Brace Fitting
 - a. Provided for use with industry standard framing channel.
 - b. Provide welded construction, two-piece linked fitting.
 - c. Provide means to reduce noise and vibration transmission between the linked fitting parts.
 - d. Manufacturers
 - 1) Superstrut C-749N series seismic brace,
 - 2) Kin-Line No. 633 seismic connector fitting,
 - 3) or equal.
 2. Hanger Rod Stiffener Assembly
 - a. Rod stiffener channel
 - 1) 1-5/8" square framing channel, Unistrut P1000, B-Line B22, Superstrut A-1200, or equal.
 - b. Rod stiffener clamps, complete with channel nut
 - 1) Superstrut ES-142, Kin-Line No. 635, or equal.
 3. Type A1 Seismic Brace
 - a. Provide 1-5/8" square framing channel, Unistrut P1000, B-Line B22, Superstrut A-1200, Kin-Line No. 4112, or equal.
 4. Type A2 Seismic Brace
 - a. Provide 1-5/8" wide by 3-3/4" deep framing channel, Unistrut P5000, B-Line B11, Superstrut H-1200, Kin-Line No. 8212, or equal.
- E. Structural Attachments
1. General
 - a. Unless otherwise specified, provide hanger rod structural attachments as specified in Section 40 05 07.
 - b. Structural attachments for longitudinal and lateral seismic braces: as specified in Paragraph 2.02.D.
 2. Type SA-1 Attachment
 - a. Brace fitting: as specified in Paragraph 2.02.D.
 - b. Concrete anchors
 - 1) As specified in Section 05 50 01 with embedment and location dimensions as specified.
 3. Type SA-2 Attachment
 - a. Brace fitting: as specified in Paragraph 2.02.D.

- b. Concrete anchors
 - 1) As specified in Section 05 50 01 with embedment and location dimensions as specified.
 - c. Framing channel
 - 1) As specified in Paragraph 2.02.F.
 - 4. Type SA-3 Attachment
 - a. Brace fitting
 - 1) As specified in Paragraph 2.02.D.
 - b. Cap screw, lockwasher and hex nut materials and finish: compatible with structural steel material.
 - 5. Type SA-4 Attachment
 - a. Brace fitting
 - 1) As specified in Paragraph 2.02.D.
 - 6. Type SA-5 Attachment
 - a. Brace fitting
 - 1) As specified in Paragraph 2.02.D.
 - 2) Angle: 4" x 3" x 3/8".
- F. Accessories
 - 1. Hanger Rods
 - a. Threaded on both ends or continuous threaded and sized as specified.
 - 2. Framing Channel
 - a. Roll formed, 12-gage.
 - b. Provide channel with a continuous slot along one side with in-turned clamping ridges.
 - c. Manufacturers
 - 1) Unistrut P1000 series,
 - 2) B-Line B22 series,
 - 3) Superstrut A-1200 series,
 - 4) or equal.
 - 3. Rod Coupling
 - a. Provide with sight hole in center of coupling body.
 - b. Manufacturers
 - 1) Anvil International. 135,
 - 2) Superstrut H-119,
 - 3) or equal.

2.3 THERMAL PIPE HANGER SHIELD

- A. Provide thermal shields at seismic restraint locations on pipe requiring insulation.
- B. Provide thermal pipe hanger shields as specified in Section 40 05 07, 2.03.
- C. Provide Type 316 stainless steel band clamps on thermal shields at longitudinal pipe restraint locations.

PART 3 - EXECUTION

3.1 PIPE RESTRAINT LOCATIONS

- A. Locate the first seismic restraint on a piping system not more than 10' from the main riser, entrance to a building or piece of equipment.
- B. Brace cast iron pipe on each side of a change in direction of 90° or more. Brace or stabilize joints in risers between floors.
- C. Brace no-hub and bell and spigot cast iron soil pipe longitudinally every 20' and laterally every 10'.
- D. Lateral bracing for one pipe section may also act as longitudinal bracing for the pipe section connected perpendicular to it, if the bracing is installed within 24" of the elbow or tee of the same size.
- E. Indicate seismic restraint locations and components on the piping layout drawings required by Section 40 05 10.
- F. Provide a legend giving load information and restraint component selection at each restraint location.
- G. Provide seismic restraint load calculations conforming to the requirements specified in Paragraph 1.06.

3.2 INSTALLATION

- A. Use rod stiffener assemblies at seismic restraints for hanger rods over 6" in length. Provide a minimum of two rod stiffener clamps on any rod stiffener assembly.
- B. Install lateral and longitudinal bracing between 45° above and 45° below horizontal, inclusive, relative to the horizontal centerline of the pipe.
- C. Construct welded and bolted attachments to the building structural steel which comply with the AISC Manual of Steel Construction. Do not drill or burn holes in the building structural steel without approval of the Construction Manager
- D. Use embedded anchor bolts instead of concrete inserts for seismic brace installations in areas below water surface or normally subject to submerging.
- E. Install thermal pipe hanger shields on insulated piping at required locations during restraint installation. Make butt joint connections to pipe insulation at the time of insulation installation per the manufacturer's recommendations.
- F. Provide restraint components in contact with plastic pipe which are free of burrs and sharp edges.
- G. Ensure rollers roll freely without binding.
- H. Provide plastic or rubber end caps at the exposed ends of all framing channels that are located up to 7' above the floor.

END OF SECTION

SECTION 40 42 13
PROCESS PIPING INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Piping insulation.

1.2 REFERENCED SECTIONS

- A. The following Section is referenced in this Section
1. Section 01 25 00 – Substitution Procedures
 2. Section 01 33 00 – Submittal Procedures

1.3 REFERENCED STANDARDS

- A. American Society for Testing and Materials (ASTM)
1. C534 – Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
 2. C547 – Standard Specification for Mineral Fiber Pipe Insulation
 3. C553 – Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
 4. D1056 – **Withdrawn 1992**: Practice for Preparation of Loose Fill Mineral Fiber Thermal Insulation Samples for Testing
 5. E84 – Standard Test Method for Surface Burning Characteristics of Building Materials
 6. E96 – Standard Test Methods for Water Vapor Transmission of Materials
- B. National Fire Protection Association (NFPA)
1. 255 – Standard Method of Test of Surface Burning Characteristics of Building Materials

1.4 SUBMITTALS

- A. Comply with Section 01 33 00.
- B. Product technical data including:
1. Acknowledgement that products submitted meet requirements of standards referenced.
 2. Manufacturer's installation instructions.
 3. Submit complete specification of insulation materials, adhesives, cement, together with manufacturer's recommended methods of application and coverage for coatings and adhesives.
- C. Submit itemized schedule by building of proposed insulation systems showing density, thermal conductivity, thickness, adhesive, jackets and vapor barriers.
- D. Certifications: Products will meet the requirements of the Contract Documents.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Elastomeric insulation:
 - a. Rubatex.
 - b. Armstrong.
 - c. Or equal.
 2. Fiberglass insulation:
 - a. Certainteed Corporation.
 - b. Schuller (Manville).
 - c. Owens Corning.
 - d. Knauf.
 - e. Or equal.
 3. PVC jacket:
 - a. Ceel-Co.
 - b. PIC Plastics.
 - c. Or equal.
- B. Submit request for substitution in accordance with Section 01 25 00.

2.2 PIPING INSULATION - ELASTOMERIC

- A. General:
1. Insulation fire and smoke hazard ratings for composite (insulation, jacket or facing, and adhesive used to adhere the facing or jacket to the insulation), as tested by procedure ASTM E84 (UL723), NFPA 255, not exceeding:
 - a. Flame spread: 25.
 - b. Smoke developed: 100.
 2. Accessories (adhesives, mastics, cements, and tapes: Same component ratings as listed above.
 3. Indicate on product labels or their shipping cartons: Flame and smoke ratings do not exceed above requirements.
 4. Permanent treatment of jackets or facings to impart flame and smoke safety is required.
 - a. Water-soluble treatments are prohibited.
 5. Insulated shields at pipe support points.
- B. Pipe, Fitting, and Valve Insulation:
1. Flexible elastomeric closed cell pipe insulation.
 - a. ASTM C534, Grade I.
 - b. Average thermal conductivity not to exceed 0.28 (Btu-IN)/(HR-FT²-DegF) at mean temperature of 75 DegF, temperature range -40 to 220 DegF; permeability not to exceed 0.20 by ASTM E96; water absorption 3 percent by **ASTM D1056** and ozone resistance.

2. Provide minimum insulation thickness conforming to schedules or as shown on the Drawings.

2.3 PIPING INSULATION - FIBERGLASS

A. Pipe and Fitting Insulation:

1. Preformed fiberglass pipe insulation:
 - a. ASTM C547 Type I:
 - 1) Density: 4 LBS/CF.
 - 2) Temperature rated: 650 DegF.
 - 3) Average thermal conductivity not to exceed 0.24 (Btu-IN)/(HR-FT²-DegF) at mean temperature of 75 DegF.
 - 4) Fire hazard rating:
 - a) ASTM E84 (UL723), NFPA 255.
 - b) Flame spread not exceeding 25 and smoke developed not exceeding 100.
 2. Moisture adsorption:
 - a. ASTM C553.
 - b. Not greater than 0.5 percent moisture by volume when exposed to moisture laden air at 120 DegF and 96 percent RH.
 3. Fungi and bacteria resistance:
 - a. ASTM C665.
 - b. Does not breed or promote growth.
 - c. Flame attenuated glass fibers bonded with thermosetting resin.
 4. Piping jackets (general applications):
 - a. Aluminum: 16 mil embossed aluminum.
 - b. PVC: Preformed 0.028 IN thick PVC jackets fabricated from B.F. Goodrich PVC sheeting V-66 with proven resistance to ultraviolet degradation when temperatures do not exceed the limits of PVC.
 - c. Piping jacket not required on concealed piping.
 5. Provide minimum insulation thickness conforming to schedules or as shown on the Drawings.

2.4 SUBSTITUTION

- A. Submit request for substitution in accordance with Section 01 25 00.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. General:
 1. Consider piping as exposed, except as otherwise indicated.
 2. Provide release for insulation application after installation and testing is complete.
 - a. Apply insulation on clean, dry surfaces after inspection.
 3. Provide insulation continuous through wall, roof and ceiling openings, pipe hangers, supports and sleeves.

4. Provide insulation with vapor barrier for piping where surfaces may be cooler than surrounding air temperatures.
 - a. Provide vapor barrier (0.17 perm-IN; ASTM C553) continuous and unbroken.
 - b. Hangers, supports, anchors, and related items that are secured directly to cold surfaces must be adequately insulated and vapor-sealed to prevent condensation.
 5. Apply specified adhesives, mastics and coatings at the manufacturer's recommended coverage per unit volume.
- C. Piping Insulation - Elastomeric:
1. Slip insulation on pipe prior to connection.
 - a. Whenever the slip-on technique is not possible provide insulation neatly slit and snapped over the pipe.
 2. Fabricate and install fitting cover insulation according to manufacturer's recommendations.
 3. Seal joints, slits, miter-cuts and other exposed edges of insulation with adhesive, recommended by the insulation manufacturer, to ensure complete vapor barrier.
- D. Piping Insulation - Fiberglass:
1. Apply over clean dry pipe.
 - a. Butt all joints together firmly.
 2. Seal joints, slits, miter-cuts and other exposed edges of insulation as recommended by the insulation manufacturer.
 3. Insulate fittings, valves, and flanges with insulation thickness equal to adjacent pipe.
 2. PVC pipe jacket:
 - a. Apply jacketing with a minimum of 1-inch overlap.
 - 1) Weld longitudinal and circumferential seams with adhesives as recommended by manufacturer.
 - b. Provide slip-joints every 30 feet and between fittings if distance exceeds 8 feet.
 - 1) Construct slip-joints by overlapping jacket sections 6 to 10 inches.
 - c. Provide premolded PVC covers of same material and manufacturer as jacket for fittings, valves, flanges, and related items in insulated piping systems.
 3. Aluminum pipe jacket:
 - a. Field-applied aluminum jacket with vapor-sealed longitudinal and butt joints.
 - b. Provide smooth and straight joint with a minimum 2-inch overlap.
 - c. Secure joints with corrosion-resistant screws spaced 0.25 to 0.50 inches back from edge.
 - d. Center spacing of screws 5 inch maximum or as required to provide smooth tight-fitted joints.
 - e. Place joints on least exposed side of piping to obtain neat appearance.

3.2 REPAIR

- A. Whenever any factory applied insulation or job-applied insulation is removed or damaged, replace with the same quality of material and workmanship

3.3 SCHEDULES

- A. Pipe, Fittings and Valves:
 - 1. Use preformed fiberglass.
 - 2. Schedule:

Application	Pipe Size	Thickness, inch	Jacket
HWR, HWS	Less than 2 inch	.05	PVC
HWR, HWS	2-inch or greater	1.5	PVC

END OF SECTION

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SECTION 40 61 00

PROCESS CONTROL SYSTEM GENERAL PROVISIONS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. A single Process Control System Integrator (PCSI) shall furnish all services and equipment for the City of Pittsburg (Owner), Water Treatment Plant controls, local communication networks, local interfaces to remote communication networks, and project field instrumentation as specified herein.
- B. The Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and Subcontractors to review all sections to ensure a complete and coordinated project.
- C. Programming of the Programmable Automation Controllers (PACs), Operator Interface Terminals (OITs), and SCADA software shall be performed by Owner staff and is not included in this Contract.
- D. Programming of the Programmable Automation Controllers (PACs), Operator Interface Terminals (OITs), and SCADA software shall be performed by the PCSI, as specified herein.
- E. Equipment shall be fabricated, assembled, installed, and placed in proper operating condition in full conformity with the Contract Documents and drawings, engineering data, instructions, and recommendations of the equipment manufacturer as approved by Engineer.
- F. The work shall include furnishing, installing, and testing the equipment and materials detailed in the following Specification Sections:
 - 1. 27 16 00 – Fiber Optic Communications Equipment
 - 2. 40 61 00 – Process Control System General Provisions
 - 3. 40 61 93 – I/O List
 - 4. 40 61 96 – Process Control Descriptions
 - 5. 40 66 43 – Wireless Network Systems
 - 6. 40 63 00 – Control System Equipment
 - 7. 40 67 00 – Control System Equipment Panels and Racks
 - 8. 40 70 00 – Instrumentation Index
 - 9. 40 71 00 – Flow Measurement
 - 10. 40 72 00 – Level Measurement
 - 11. 40 73 00 – Pressure Measurement
 - 12. 40 74 00 – Temperature Measurement
 - 13. 40 75 00 – Process Liquid Analytical Measurement
 - 14. 40 76 00 – Process Gas Analytical Measurement

15. 40 79 00 – Miscellaneous Instruments
 16. 40 80 00 – Commissioning of Process Control Systems
- G. Where differences exist between the specific equipment Specification Sections of Division 40 and this general equipment Specification Section, the specific equipment Specifications shall govern.

1.2 SCOPE OF WORK

- A. The PCSI work shall include the following:
1. Provide all materials, equipment, labor, and services required to achieve a fully integrated and operational control system. The PCSI shall design and coordinate the instrument and process control system for proper operation with related equipment and materials furnished under other Sections of these Specifications and with related existing equipment.
 2. Coordination of modification or demolition of the existing control system, adhering to the schedule of work, for transition to the new control system from the Owner's existing system.
 3. All field instrumentation, sensors, analyzers, and devices as shown and as specified for monitoring and control functions.
 4. Auxiliary and accessory devices necessary for system operation or performance, such as transducers, isolators, signal converters, intrinsically safe barriers, or relays to interface with existing equipment or equipment provided under other Sections of these Specifications, whether they are shown on the Drawings or not.
 5. Provide all PAC programming and Human Machine Interface (HMI) configuration including development of control programs, database configuration, graphic screens, communication links, historical data collection, and other programming tasks as specified herein. Coordinate all programs with the Owner to ensure that the HMI development, PAC programs, communications architecture, databases and other SCADA elements match the existing Owner approach and standards as specified herein. The existing Owner HMI screens and operator interfaces shall be used as templates for matching look and feel to the greatest extent possible.
 6. All programming of the existing facility SCADA system components shall be performed by Owner staff. However, PCSI shall be responsible for implementing the upgrades to the hardware and software. PCSI shall coordinate with Owner staff for the work to be performed by the Owner at the facility, implementing the system switchover (including data addressing coordination) between new and old equipment with the platforms at central Control Room, and implementing successful delivery of process control and diagnostic data. PCSI shall also furnish a fully configured server node to the Owner for installation facility by Owner staff.
 7. Facilitate, coordinate, and take full responsibility for integration of equipment resident on the control system network that is provided under other Sections of these Contract Documents. Establish networking addressing scheme and operational criteria for all network devices provided under this Contract including VFDs, power monitors, motor monitoring devices, PACs, and other equipment as shown on the Drawings. All network addressing for new equipment shall be coordinated with and approved by Owner IT staff prior implementation.
 8. Match the look and feel of the existing Owner PAC and HMI programming and graphical interfaces to the greatest extent possible for the new equipment provided under this Contract. Samples of the existing HMI graphic screens are included in **Appendix 40 61 00-A** for examples of process graphic symbols, color conventions,

screen layouts, and formatting schemes. Control system configuration by the PCSI shall include the following:

- a. Perform real-time process control, including proportional integral derivative control action, individual equipment start and stop sequencing, process calculations, etc. as described in Section 40 61 96.
 - b. Collect and store historical operating information for present and future reporting and maintenance uses.
 - c. Assist operating personnel by noting and communicating off-normal operating conditions and equipment failures.
 - d. Accumulate and store equipment running times and starts for use in preventative maintenance.
 - e. Provide color graphic displays and reports for use by the system operating and supervisory personnel.
 - f. Provide trending for all analog values.
 - g. Provide control system diagnostics.
 - h. Perform all process control functions including PID, calculations, sequencing, timing, etc., in the PAC controllers. No real-time process control functions shall be implemented at the HMIs.
 - i. Include provisions to allow the operators to manually control and view the status of all process equipment from the HMI.
 - j. Develop data acquisition scheduling strategy for periodic or scheduled access of both real-time process control variables and on-demand historical data used for Owner condition assessment or asset management functions.
- B. The PCSI shall use the equipment, instrument, and loop numbering scheme that has been developed and shown on the Drawings. The PCSI shall also utilize the process control descriptions located in Section 40 61 96 in the development of the PCSI's submittals. The PCSI shall not deviate from or modify said numbering scheme or process control logic without the Engineer's approval.
- C. The following is a list of facilities where work will be performed. All work shall be coordinated with its operating personnel to minimize impact on operation. The existing facilities are as follows:
1. Pittsburg Water Treatment Plant
- D. Related Work
1. Control System Architecture Block Diagram is included in the Drawings
 2. Piping and Instrumentation Diagrams (P&IDs) are included in the Drawings
 3. Appendix 40 61 00-A: ***[add appendices for the Owner's standards or examples of programming and HMI development. Use separate sections for I/O lists and Instrument Index. Provide example drawings, such as loop diagrams and wiring diagrams, as part of the project Drawing package].***

1.3 SUBMITTALS

A. General

1. Shop drawings shall be submitted as specified in [Section 01 33 00, Special Provisions]. They shall be complete; giving equipment specifications, details of connections, wiring, ranges, installation requirements, and specific dimensions. Submittals consisting of only general sales literature will not be acceptable.
2. Check shop drawings for accuracy and contract requirements prior to submittal. Shop drawings shall be stamped with the date checked and a statement indicating that the shop drawings conform to Specifications and Drawings. This statement shall also list all exceptions to the Specifications and Drawings. Shop drawings not so checked and noted shall be returned unreviewed.
3. Engineer's review of submittals shall be for conformance with the design concept of the project and compliance with the Specifications and Drawings. Errors and omissions on approved shop drawings shall not relieve the Contractor from the responsibility of providing materials and workmanship required by the Specifications and Drawings.
4. Field verify all dimensions at the Project site and coordinate with the work of all other trades and work being performed by the Owner.
5. Shop drawings shall fully demonstrate that the equipment and services to be furnished comply with the provisions of these Specifications and shall provide a true and complete record of the equipment as manufactured and delivered.

B. Submittal Requirements

1. Submittals shall be bound in separate three-ring binders, with an index and sectional dividers, with all drawings provided in 11-inch by 17-inch format for inclusion within the binder.
2. The submittal drawings' title block shall include, as a minimum, the PCSI's registered business name and address, project name, drawing name, revision level, and personnel responsible for the content of the drawing.
3. Separate submittals shall be made for:
 - a. Project Plan, Deviation List, and Schedule ***[Include the project plan submittal only on relatively large and complex projects that require significant coordination]***
 - b. Coordination Workshops Agendas
 - c. Field Instrumentation
 - d. SCADA Hardware
 - e. SCADA Software and Programming
 - f. Control Panel Submittal
 - g. Loop Wiring Diagrams
 - h. Network Diagrams
 - i. Testing Plan
 - j. Training Plan
 - k. Spares, Expendables, and Test Equipment

C. Project Plan, Deviation List, and Schedule

1. The PCSI Project Plan shall be submitted and favorably reviewed before any further submittals will be accepted or reviewed. Any and all project submittals received prior to submittal and favorable review of the Project Plan shall be returned to the Contractor with a "Not Reviewed" status.
2. Project Plan shall, at a minimum, contain the following:
 - a. Overview of the proposed control system in clear text format describing the PCSI's understanding of the project work, system architecture drawing, interfaces to other systems, schedule, startup, and coordination.
 - b. Approach describing how the PCSI intends to execute the work written in clear text format. Approach shall include a discussion of procurement, fabrication, testing, installation, switchover, startup, replacement of existing equipment with new, interim operations, etc. as applicable for this Project.
 - c. Proposed list of anticipated shop drawings and submittals.
 - d. Preliminary software design specification based on the requirements of the Contract Documents. The software design specification shall define how the new software will be configured, developed, and implemented with particular emphasis on how the new system will interact with operators at the HMI and local operator panel level. The Software Design Specification shall include the following at a minimum; provide additional information as required to provide a comprehensive description of the software development phase:
 - 1) Introduction: Purpose, scope, and document overview
 - 2) Full system architecture description including a block diagram that describes the networking implementation, segmenting, and routing for communication and telemetry networks for all new and existing networked devices included under this Contract.
 - 3) Hardware platforms: comprehensive descriptions
 - 4) Software component: comprehensive descriptions
 - 5) Method for coordination of the software development with Owner standards and existing platforms including communication addressing; database structure and formats; HMI screen development approach and method for matching Owner Look-and Feel; PAC coding; access method for third party device data streams (e.g. ASD equipment).
 - 6) Method for inter-platform exchange of data with description of memory mapping and block data transfer techniques.
 - 7) Glossary of terms
 - e. Preliminary software and hardware submittal information solely to determine initial compliance with the requirements of the Contract Documents prior to the PCSI development of process control programs and system layouts. Favorable review of software and hardware systems as part of this Project Plan stage shall not relieve the PCSI of meeting all the functional and performance requirements of the system as specified herein.

- f. Project personnel and organization including the PCSI project manager, project engineer, and lead project technicians. Include resumes of each key individual including the registered engineer in responsible charge for the project. Submit confirmation in writing of the commitment to this project for all key staff.
 - g. Preliminary coordination workshop agendas as specified herein.
 - h. Preliminary testing plan for each test phase. Preliminary plan shall include representative signoff sheet
 - i. Preliminary training plan
3. Exceptions to the Specifications or Drawings shall be clearly defined by the PCSI in a separate Deviation List. The Deviation List shall consist of a paragraph-by-paragraph review of the Division 40 Specifications indicating conformance or any proposed deviations, the reason for exception, the exact nature of the exception and the proposed substitution so that a proper evaluation may be made by Engineer. The acceptability of any device or methodology submitted as an “or equal” or “exception” to the specifications shall be at the sole discretion of Engineer.
4. Project schedule shall be prepared and submitted using Microsoft Project scheduling software or similar. Schedule shall be prepared in Gantt chart format clearly showing all major tasks, task dates and durations, milestone dates, linkages between tasks, and identification of critical path elements. At a minimum, the project schedule included in the project work plan for the control system work specified in Division 40 shall include:
- a. Demonstration of coordination with the overall project plan provided by the General Contractor under Special Provisions.
 - b. All subsequent control system project submittals. Include in the scheduled time durations the time required for PCSI submittal preparation and submittal review. Include provision for a minimum of two complete review cycles.
 - c. Proposed dates for all project Coordination Workshops.
 - d. Hardware purchasing, fabrication, and assembly (following approval of related submittals)
 - e. Software purchasing and configuration (following approval of related submittals)
 - f. Shipment of all field instrumentation and control system equipment
 - g. Installation of all field instrumentation and control system equipment.
 - h. Testing: Schedule for all testing including at a minimum the testing sequence as specified under Part 3. Testing schedule shall include submittal of test procedures a minimum of 30 days prior to commencement of testing. Schedule shall also include submittal of completed test procedure forms for review and approval by Engineer and Owner prior to shipment, startup, or subsequent project work.
 - i. Schedule for system cutover, startup, and/or going on-line for each major system. At a minimum include the schedule for each process controller and HMI servers/workstations provided under this Contract.
 - j. Schedule for all training including submittal and approval of O&M manuals, factory training, and site training.
 - k. Submittal of Certification of Installation

- I. Warranty and extended warranty period as applicable
- D. Coordination Workshops Agendas: Agendas shall be submitted for the Coordination Workshops as specified herein. Submit proposed Control System Coordination Workshop Agendas a minimum of four weeks prior to the scheduled workshop dates for review and comment by Engineer and modification by the PCSI as required.
- E. Field Instrumentation
 - 1. Submit complete documentation of all field instruments using ISA-S20 data sheet formats. Submit a complete Bill of Materials (BOM) or Index that lists all instrumentation equipment ordered by the loop numbering system as shown in the Contract Documents.
 - 2. Submit separate data sheets for each instrument including:
 - a. Plant or Site equipment number and ISA tag number.
 - b. Product (item) name used herein and on the Contract Drawings.
 - c. Manufacturer's complete model number.
 - d. Location of the device.
 - e. Input - Output characteristics (wiring, voltage, current ratings, etc.).
 - f. Range, size, and graduations in engineering units.
 - g. Physical size with dimensions, enclosure NEMA classification and mounting details in sufficient detail to determine compliance with the requirements of the Contract Documents.
 - h. Materials of construction for enclosure and wetted parts.
 - i. Instrument or control device sizing calculations where applicable.
 - j. Certified calibration data for all flow metering devices.
 - k. Two-wire or four-wire device type as applicable.
 - l. Submit index and data sheets in electronic format as well as hard copies on 8-1/2" x 11" formats. Electronic format shall be in Microsoft Excel or Word. Submit electronic copy on USB flash drives, or secure file sharing cloud storage, formatted for MS-Windows compatible computers.
- F. SCADA Hardware Submittal
 - 1. Catalog cuts and descriptive literature for programmable automation controllers (PAC), including central processing units, memory, input modules, output modules, communication interfaces, network interface modules, mounting racks, and power supplies. Submit system bill of materials and descriptive literature for each hardware component that fully describes the units being provided.
 - 2. Any deviations of the hardware systems from the preliminary hardware submittal included in the Project Plan shall be described in detail.
 - 3. Catalog cuts and descriptive literature for HMIs, peripherals, UPS units, and power supplies. Submit system bill of materials and descriptive literature for each hardware component, which fully describes the units being provided.
 - 4. Complete system Input/Output (I/O) list for equipment connected to the control system under this Contract. The I/O list shall be submitted in both a Microsoft Excel readable electronic file format and an 8-1/2 inch by 11-inch hard copy. The I/O list shall include I/O name (or spare), type, physical location, point address, functional

description (text that includes signal source, control function, etc.), range (Engineering units), relay normal status contact configuration (i.e. relay logical condition for a normally open contact state or normally closed contact state). Both hard I/O and network device I/O shall be included. The I/O list shall be sorted in order by:

- a. Physical location: Panel, Rack, CPU Name, or Remote I/O Drop
 - b. Source interface: Hardwired I/O, Ethernet or Serial communication
 - c. I/O Type: AI, AO, DI, DO etc.
 - d. Loop Number
 - e. Source device Tag
5. Complete block diagram showing the inter-connections between major hardware components, media type between components, raceway requirements (conduit, wireway, etc.), raceway identification, network protocol used at each network level, and all hardware components showing the interconnection of all modules, interface devices, network switches, routers, and protocol converters.
 6. Battery system sizing data for backup DC power supply systems. Submit specific equipment power requirements for equipment listed as critical per Section 40 67 00. Battery system shall be sized and furnished by the PCSI as required in the Contract Documents and based on the backup power duration required for the application.
 7. UPS sizing calculations to verify compliance with the specified power usage and backup power duration requirements for equipment where required in the specifications or shown on the Drawings.
 8. Submit power consumption (VA) of critical loads where shown as required on the Drawings.
 9. Submit final circuit and cable labeling scheme for review and approval by the Owner prior to development of panel fabrication, connection, schematic, and loop drawings.
 10. A list of all hardware electrical and environmental characteristics and requirements. All planning information, site preparation instructions, grounding and bonding procedures, cabling diagrams, plug identifications, safety precautions or guards, and equipment layouts to enable the Contractor to proceed with the detailed site preparation for all equipment.

G. SCADA Software and Programming Submittal

1. Submit details of the PAC and HMI application packages to be used. Indicate all standard and optional features provided. Include copies of license agreements indicating assignment of licenses to the Owner.
2. Any deviation of the software platforms from the preliminary software submittal included in the Project Plan shall be described in detail.
3. Specify programming language types and approach to be used for all PAC programming. Detail how Function Block Diagram (FBD), Ladder Logic (LD), and Structured Text (ST) programming will be implemented on the project and the specific applications in which each will be used.
4. Submit electronic files of the software logic and documentation for the PAC programs developed for the Project. PAC program files shall be submitted in the native format of the manufacturer's programming software and include all files and backup archives necessary to review, compile, and load the programs.

Documentation and programming approach shall match existing Owner programming format to the greatest extent possible. At a minimum, each program module, subroutine, or function block shall be fully described in a program overview that defines the inputs, outputs, definition of constants and internal variables, and function of the routine. The program overview shall be stored as a separate MS-Word document for inclusion in the O&M manuals.

5. Program documentation shall be comprehensive and include clear descriptions for all program elements (rungs, networks, function blocks, command descriptions, etc.) with abundant comments to clearly identify function and intent. For example, for ladder logic, the link between “coil” and “contact” shall be clearly presented (i.e. clear cross-reference between a coil and all instances of the associated contacts for that coil), the function of each timer described, the purpose of each user-defined function block, the purpose of each user-defined data type, etc. A similar level of documentation shall be provided for all programming languages used.
6. Program documentation shall be sufficiently clear to allow determination of compliance with the process control requirements included in the Process Control Loop Descriptions included in Section 40 61 96 and the Drawings. The software submittal shall demonstrate that all logic provided under this project follows the same structure and format and reflects a common programming approach.
7. Submit details of control system communication. Submit hardware and software configuration information in sufficient detail to verify performance of the wired and/or wireless communication systems as detailed herein and on the Drawings. Include details of any necessary communication devices, special interface requirements (e.g., cables, jacks, etc.), description of drivers and impact of drivers on controller memory configuration. Any specific communication block memory addresses shall be defined.
8. Submit details of the data transfer implementation for exchanging data between devices and platforms provided under this the Section, new equipment provided under this Contract, and SCADA equipment. Indicate addressing and block transfer schemes conforming to Project requirements for all data exchanges. Develop data transfer implementation for real-time process control data and on-demand condition data that does not require real-time data but rather uses a longer term scheduled data delivery scheme per Section 40 61 96. Refer to the following sections for additional details of the data exchange requirements.
 - a. Process equipment specified Division 11
 - b. Variable Speed Drives
 - c. Reduced Voltage Soft Starters
 - d. Intelligent motor protection relays and devices
 - e. Other facility PACs
 - f. Existing facility HMIs
 - g. Power monitoring
9. Submit memory maps or user-defined data structures indicating data sets to be transferred between networked devices as required for the monitoring and control functions specified and as shown on the Drawings. Submit the method for implementing the network and control system equipment diagnostics per Section 40 61 96.
10. Submit memory usage reports for each PAC. Reports shall be in spreadsheet format and indicate both used and unused memory. Include constant and variable memory assignment records that tabulate area, location, number, and description

of each numeric constant and variable. Total memory used for variables, logic, and all other data stored in PAC memory shall be tabulated and the total used, and spare memory indicated to confirm the specified memory requirements.

11. Submit programming standard functions, methods, and logic for each PAC programmed including process control logic and internal housekeeping programs and routines including redundancy, heartbeat, clock synchronization, value scaling, alarm handling, etc.
 12. Submit details on the implementation of communications between the PACs and the SCADA software. Include data on driver software, OPC server configuration, planned polling rates for the various data types and process parameters, and methods for handling communication failures and switching to backup modes of communication.
 13. Submit final drafts of logs, reports, trends, and HMI process graphic displays. The HMI graphic displays submittal shall include a Legend screen that defines color usage for status, alarms, static text, process values, trends, and setpoints. The specifics of what shall appear on each display and report and what calculations are required to support them shall be described. Final drafts shall reflect the system requirements as specified herein as well as the result of the Coordination Workshops with the Owner and Engineer.
- H. Control Panel Submittal: Submittals and drawings shall be furnished for all panels, consoles, and equipment enclosures specified in Section 13420. Panel assembly and elevation drawings shall be drawn to scale and detail all equipment in or on the panel. As a minimum, the panel drawings shall include the following:
1. Interior and exterior panel elevation drawings to scale.
 2. Panel total weight including all components.
 3. Nameplate schedule.
 4. Conduit access locations for top or bottom entry.
 5. Panel construction details.
 6. Cabinet assembly and layout drawings to scale. The assembly drawing shall include a comprehensive bill of material on the drawing with each panel component clearly defined. The bill of material shall be cross-referenced to the assembly drawing so that a non-technical person can readily identify any component of the assembly by manufacturer and model number.
 7. Fabrication and painting specifications including color (or color samples).
 8. Panel control schematics and interconnection diagrams detailing the electrical connections of all equipment in and on the panel. Diagrams shall include at a minimum power and signal connections; UPS, critical (battery), and non-critical (normal) power sources; all panel ancillary equipment; protective devices; wiring and wire numbers; wire colors; and terminal blocks, terminal block colors, and numbering.
 9. I/O Module wiring diagrams depicting both internal and external field device wiring between the field device connection points and the I/O module terminals.
 10. Control panel component catalog data and cut sheets for all control panel equipment provided.
 11. AC and DC load calculations for each panel supplied indicating conformance with proper sizing of incoming panel circuits, UPS systems, and DC power supplies. Load calculations shall include a minimum 50% spare capacity, or spare capacity as indicated in the specification requirements for the individual components.

12. Heating and cooling calculations for each panel supplied indicating conformance with cooling requirements of the supplied equipment and environmental conditions. Calculations shall include the recommended type of equipment required for both heating and cooling that will ensure maintaining the integrity of the NEMA panel rating.
13. Standby power and UPS calculations as required. Load calculations shall include an estimate of the backup power duration in the event of a utility or source power failure.
14. Submit evidence that all control panels shall be constructed in conformance with UL-508A and bear the UL Label confirming the construction. Specify if UL compliance and seal application shall be accomplished at the fabrication location or by field inspection by UL inspectors. All costs associated with obtaining the UL Label and any inspections shall be borne by the Contractor and included in the Project Bid Price.
15. Submit anchorage calculations to comply with seismic requirements as specified in 01 33 16.12.

I. Loop Wiring Diagrams

1. Loop Wiring Diagrams: Provide electrical I/O wiring diagrams on a loop-by-loop basis depicting wiring within the panel as well as connections to external devices including analog instruments, digital switches, instrumentation, starters, drives, and panel mounted devices.
 - a. Layout, format, and labeling used on the loop drawings shall match format and level of detail per ISA-5.4 standards including completion of all project and panel and component specific name and model number placeholders, protection devices, wire and cable identification labeling, power supply connections, specific circuit and panel specified requirements, addressing, variable names, etc.
 - b. Field device wiring labels shall include the device ISA tag and loop number as shown on the Drawings along with the associated control panel, terminal block and terminal number where the wire lands with an additional alpha suffix if required to ensure uniqueness. For example:

LIT0167(+)-MCP-TB3-122

- c. Control panel to control panel wiring labels shall include the source control panel, terminal block, and terminal number followed by destination control panel, terminal block, and terminal number with an additional alpha suffix if required to ensure uniqueness, For example:

MCP-TB1-35-LCP-TB1-56

- d. Field wiring for analog points shall include wire labels for all signal conductors.
- e. All field wiring shall include conduit routing on the loop diagram.
- f. Process controller I/O wiring shall be numbered with rack number, slot number, and point number and panel termination terminal block and terminal number as applicable.
- g. Process controller communication modules, or other special systems wiring shall be numbered with rack number, slot number, and port number as applicable.
- h. Electrical schematics shall include 120 VAC and 24 VDC power supply circuitry including line filters and surge protection devices, 24 VDC power

supplies, chargers for battery application where required, and terminal block distribution for AC, non-critical (DC), and critical (battery) powered loads.

- i. Two-wire, three-wire, and four-wire equipment shall be clearly identified and power sources shown on the drawing.
- j. All panel and field wiring shall be tagged and indicated on the loop diagram. Submit final wire numbering scheme for approval by Owner. Complete all terminal block identification and terminal numbers.
- k. Provide loop diagrams under this Contract for all new and **existing field devices** *[verify this for the specific project requirements]*. Existing wiring documentation of existing panels and SCADA equipment shall be field verified by the PCSI.
- l. The PCSI shall be responsible for coordinating and developing loop diagrams for packaged equipment systems that are interconnected to PCSI provided PAC and I/O panels. The packaged equipment system supplier shall be responsible for developing loop diagrams for field devices and control panels that are provided as part of the packaged equipment system and isolated from connections to other systems and process equipment.

J. Network Diagrams

1. Submit network diagrams for Ethernet and serial communication systems. The network diagrams shall contain the physical wiring layout showing network connections, fiber optic connections, telemetry connections, networked devices, remote I/O devices, firewalls, network switches, routers, and protocol converters. Indicate media transitions from copper to fiber, fiber to copper, wireless to wired, etc. Identify all equipment and physical location of each (enclosure, panel, etc.).
2. Network diagrams shall include details on media (fiber, Cat-6, etc.), radio frequencies, communication protocols, communication speeds, and device addresses. CAD files used to develop the drawings shall include layering of technical information so that drawings can be printed or published without showing information that is deemed sensitive by the owner.

K. Testing Plan

1. Test Procedure Submittals: Submit the procedures proposed to be followed for each test. Procedures shall include test descriptions, forms, and checklists to be used to control and document the required tests. Include sign-off forms for each testing phase or loop (per the Specifications) with sign-off areas for the PCSI, the Owner, and the Engineer. Refer to Part 3 of this Section *[or Section 40 80 00]* for testing requirements. Submit separate procedures for each specified test phases including:
 - a. Unwitnessed Factory Test (UFT)
 - b. Witnessed Factory Test (WFT)
 - c. Operational Readiness Test (ORT)
 - d. Functional Acceptance Test (FAT)
 - e. 30-Day Acceptance Test.
2. Test Documentation: Upon completion of each required test, document the test by submitting a copy of the signed off test procedures. Testing shall not be considered complete until the signed-off test procedures have been submitted and

favorably reviewed. Submittal of other test documentation, including “highlighted” I/O electrical schematic wiring diagrams with field technician notes are not acceptable substitutes for the formal test documentation.

L. Training Plan

1. Training Plan Submittal: Upon receipt of Engineer's comments on the preliminary training plan included in the Project Plan **[if the project plan is part of the requirements]**, submit a final training plan. The training method and coverage shall be in conformance with the system training as specified in Section 01 79 00. The training plan shall include:
 - a. Definitions of each course.
 - b. Specific course content outline.
 - c. The target audience for each course.
 - d. Schedule of training courses including dates, duration, and locations of each class.
 - e. Resumes of the instructors who will implement the plan.

M. Spares, Expendables, and Test Equipment Submittal

1. Submit for each Subsystem:
 - a. A list of, and descriptive literature for, spares, expendables, and test equipment to be provided under this Contract as required by the related technical Specification Sections of Division 40.
 - b. A separate list of, and descriptive literature for, additional spares, expendables and test equipment recommended by the PCSI.
 - c. Storage instructions for all spare parts.

1.4 REFERENCE STANDARDS

- A. Publications are referred to in the text by basic designation only. Where a date is given for reference standards, that edition shall be used. Where no date is given for reference standards, the latest edition in effect at the time of bid opening shall apply.
- B. American Society for Testing and Materials (ASTM).
 1. ASTM A269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
- C. American National Standards Institute (ANSI)
 1. ANSI X3.5 - Flowchart Symbols and Their Usage in Information Processing
- D. International Electrotechnical Commission (IEC)
 1. IEC 61131 – 3 – International Standards, Programmable Controllers – Part 3 Programming Languages
- E. Institute of Electrical and Electronic Engineers (IEEE)
 1. IEEE Standard C2 – National Electrical Safety Code (NESC)
 2. IEEE Standard 472 - Electrical Surge Protection
 3. IEEE Standard 802.X – LAN/MAN Standards

- F. Electronic Industries Alliance (EIA)
 - 1. EIA Standard RS-232-C – Interface between data terminal equipment and data communication equipment employing serial binary data interchange.
 - 2. EIA Standard RS-422-A – Electrical characteristics of balanced voltage digital interface circuits

- G. International Society of Automation (ISA)
 - 1. ISA S5.2 - Binary Logic Diagrams for Process Operations
 - 2. ISA S5.3 - Graphic Symbols for Distributed Control/Shared Display Instrumentation Logic and Computer Systems.
 - 3. ISA S5.4 - Instrument Loop Diagrams
 - 4. ISA S20 - Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
 - 5. ISA 18.2 – Management of Alarm Systems for Process Industries.
 - 6. ISA RP60.3 - Human Engineering for Control Centers
 - 7. ISA RP60.6 - Nameplates, Labels, and Tags for Control Centers
 - 8. ISA 101.01 – Human Machine Interfaces for Process Automation Systems

- H. National Fire Protection Agency (NFPA)
 - 1. NFPA 70 - National Electrical Code.

- I. National Electrical Manufacturers Associations (NEMA)
 - 1. NEMA ICS6 - Enclosures for Industrial Controls and Systems

- J. Underwriters Laboratories, Inc. (UL)
 - 1. UL 508 – Industrial Control Equipment

1.5 QUALITY ASSURANCE

- A. The equipment and components specified herein were current products at the time of the design. Should the specified equipment become unavailable during construction, due to obsolescence or loss of commercial availability, the contractor shall provide the latest product within the manufacturer's product line for approval, or equivalent that meets the technical requirements of the specification.

- B. The PCSI shall be a "systems house" regularly engaged in the design and the installation of instrumentation systems and their associated subsystems as they are applied to the municipal water and wastewater industry.
 - 1. For the purposes of this Specification Section, a "systems house" shall be interpreted to mean an organization that complies with all the following criteria:
 - a. Employs a professional Control Systems Engineer or Electrical Engineer registered in the State of **California** to supervise or perform the work required by this Specification Section.
 - b. Employs personnel on this project who have successfully completed ISA or manufacturers' training courses on general process instrumentation and configuration and implementation of the specific process controllers, computers, and software proposed for this project.

- c. Has performed work of similar or greater complexity on at least five previous projects.
 - d. Has been actively engaged in the type of work specified in this Specification Section for a minimum of five years.
 - e. Has been actively engaged in industrial process control programming and system integration for a minimum of ten years.
 - f. Has been actively engaged in HMI configuration and system integration for a minimum of five years.
2. The PCSI shall maintain a permanent, fully staffed and equipped service facility within 4 hours travel time of the project site with full-time employees capable of designing, fabricating, installing, calibrating, and testing the systems specified herein. At a minimum, the PCSI shall be capable of responding to on-site problems within 12 hours of notice.
 3. Actual installation of the instrumentation system need not be performed by the PCSI's employees; however, the PCSI as a minimum shall be responsible for the technical supervision of the installation by providing on site supervision to the installers of the various components.
 4. The PCSI shall furnish equipment that is the product of one manufacturer to the maximum practical extent. Where this is not practical, all equipment of a given type shall be the product of one manufacturer.
 5. The PCSI shall be one of the following or equal as approved by the Owner.
 - a. Technical Systems, Inc., Dixon, California (707-678-1111)
 - b. Telstar Inc., Concord, California (925-671-2888)
 - c. Primex Controls, Vacaville, California (707-449-0341)
 6. Only approved suppliers will be accepted. The Contractor shall name the proposed system supplier per the requirements of the Special Provisions.
 - a. Cover Letter:
 - 1) Company name, contact name, address, fax number and email address
 - b. PCSI Qualifications:
 - 1) The PCSI shall provide responses to all items listed in Section 40 61 00, Article 1.5 - Quality Assurance"
 7. Being listed in this Section does not relieve any potential PCSI from meeting the qualifications specified in this Section. However, listed suppliers will not be required to submit a qualifications proposal. Suppliers interested in being listed as an equal to the above-listed suppliers shall submit three copies of a qualifications proposal to the Owner no later than four weeks before the bid opening date. Based on a review of the contents and completeness of the submitted data, a list of any approved equals shall be issued by the Owner no later than five days before the bid opening date.

1.6 SYSTEM DESCRIPTION

- A. The new filter and chemical process areas will be controlled and integrated into the existing plant control system. The new filter process area will receive new PAC panels comprised of one primary control panel and one remote I/O panel and an associated expansion of the SCADA HMI system to include access in the new filter building. The existing main plant

PAC will be expanded with a new remote I/O panel for the replacement chemical systems. The existing GE Proficy iFIX SCADA application will expand to include the new process areas and updated to remove the replaced process areas.

- B. A mix of copper and fiber optic cables will be used for data exchange between panels. The new filter control panel will connect to the existing plant control network using a new fiber optic connection to the main control room. The new remote I/O panel for the chemical systems will connect to the existing main plant PAC using Profinet.
- C. The existing chlorine gas and filter process areas shall remain functional during construction of the new filter process area. Planned outages and the transition between the existing and new systems shall be coordinated to avoid loss of process capabilities.
- D. Existing PAC and SCADA HMI applications will be modified to remove programming elements for the existing chlorine and filter processes as well as any other abandoned logic and configurations due to updates by this project once the replacement processes areas are in service. This shall be coordinated with the Owner.

1.7 DELIVERY, STORAGE AND HANDLING

A. Shipping Precautions

- 1. After completion of shop assembly, factory test and approval of all equipment, cabinets, panels and consoles shall be packed in protective crates and enclosed in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust and moisture. Dehumidifiers shall be placed inside the polyethylene coverings. The equipment shall then be skid-mounted for final transport. Lifting rings shall be provided for moving enclosures without removing protective covering. Boxed weights shall be shown on shipping tags together with instructions for unloading, transporting, storing and handling at the job site.
- 2. Special instructions for proper field handling, storage and installation required by the manufacturer for proper protection, shall be securely attached to the packaging for each piece of equipment prior to shipment. The instructions shall be stored in resealable plastic bags or other acceptable means of protection.
- 3. None of the HMI control and monitoring equipment shall be shipped to the site until the designated control room and/or process areas are environmentally stable and suitable for the equipment. The Contractor and PCSI shall accept the equipment on delivery and supervise unloading within the control room areas.
- 4. All equipment furnished under related Specification Sections of Division 40 shall be shipped to the job site via dedicated air ride van.

B. Shipping Coordination

- 1. Coordinate shipping and installation of the PCSI supplied equipment with the requirements of the overall Contractor's construction schedule to ensure timely delivery of instruments, control panels, and SCADA hardware, as specified in the Contract Documents.

C. Identification During Shipping and Storage

- 1. Each component shall be tagged to identify its location, tag number and function in the system. Identification shall be prominently displayed on the outside of the package.

D. Storage

1. Equipment shall not be stored out-of-doors. Equipment shall be stored in dry permanent shelters including in-line equipment and shall be adequately protected against mechanical damage. Equipment stored in untreated spaces shall have condensation space heaters installed to prevent moisture condensing on or within the equipment. Provide suitable power source for space heaters as required.
2. If any apparatus has been damaged, such damage shall be repaired by the PCSI at his/her own cost and expense. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and put through such tests as directed by Engineer. This shall be at the cost and expense of the PCSI, or the apparatus shall be replaced by the PCSI at no additional cost.

1.8 PROJECT/SITE REQUIREMENTS

A. Elevation: Equipment shall be designed to operate at a ground elevation of approximately 1500 feet above mean sea level.

B. Temperature:

1. Outdoor area equipment shall be suitable for operation at temperatures from -10° to +50° C degrees ambient.
2. Interior area equipment shall be suitable for operation in conditioned spaces from +10° to +40° C degrees ambient
3. Storage temperatures shall range from -10° to 50° C degrees ambient minimum.
4. Additional cooling or heating shall be furnished by the PCSI under the Contract Bid Price if required to conform to the indicated operating or storage temperatures as specified herein.

C. Relative Humidity. Air-conditioned area equipment shall be suitable for 20 to 95 percent relative, non-condensing humidity. All other equipment shall be suitable for 0 to 100 percent relative, condensing humidity.

D. Power Supply: 120 volts AC sources of electrical power supply shall be from unregulated industrial panel boards (either utility or standby generator) unless a UPS power source is indicated on the Drawings.

E. Ozone/Oxygen Service: Where equipment covered under this Specification Section is to be exposed to gaseous, liquid, or mixtures of ozone, oxygen, ozone off-gas, and ozone vent gas the following shall apply:

1. All instrumentation equipment, valves, analyzers, seals, gaskets, valve seats and associated appurtenances shall be cleaned, sealed, and protected in accordance with CGA publication G-4-1 and certified for oxygen service before shipping.
2. All equipment, valves, valve seats, analyzers, seals, gaskets, welds, and all associated appurtenances shall be specially certified resistant to degradation and gas losses due to the use of these gases or liquids.
3. Greases and lubricants shall be oxidation resistant and shall be Dupont "Krytox" for the above-noted special services.
4. Gaskets shall be expanded PTFE, Teflon, or Viton "A".
5. All pipe, tube, fittings, couplings, and appurtenances for use with these services shall be Type 316L stainless steel.

6. Where necessary, diaphragm seals shall be provided as specified herein.

1.9 MAINTENANCE

A. Test Equipment

1. Additional test equipment as defined in the related technical Specification Sections of Division 40.

B. Spare Parts

1. Provide spare parts of the type and quantity as specified herein and as specified in the related technical specifications of Division 40.
2. All spare parts shall be carefully packed in cartons, labeled with indelible markings, and shall be adequately treated for a long period of storage. Complete ordering information including manufacturer's part number, part ordering information including manufacturer, part number, part name, and equipment name and number(s) for which the part is to be used shall be supplied with the required spare parts. The spare parts shall be delivered and stored in a location directed by Owner.
3. In addition to the spare parts specified under the related technical specifications of Division 40, provide the following:
 - a. Example: Six of each type cable connector provided.
 - b. Item 2
 - c. Item 3

1.10 WARRANTY

- A. Warranty period and requirements shall be as defined in Special Provisions/Section 01 78 36.
- B. Provide software updates and installations throughout the warranty period. Provide latest official released versions for all software provided under this Contract. The Owner shall have the latest software releases at the end of the warranty period. However, only software releases approved for use by the Owner shall be installed on the Owner systems, and installation shall only be made upon specific written approval by the Owner.

1.11 COORDINATION WORKSHOPS

- A. The PCSI shall schedule and hold ten mandatory control system Coordination Workshops during the Project. The Coordination Workshops shall include as a minimum the Owner, the Engineer, the Contractor, the PCSI's Project engineer, and electrical subcontractor. Owner staff shall include construction managers, technicians, operators, and maintenance staff as required. The Owner shall determine which staff members will attend each workshop. Workshops shall all be held at the 300 Olympia Dr. Pittsburg, CA, 94565.
- B. Schedule the Coordination Workshops a minimum of two weeks prior to the workshop date and include a draft agenda at the time of the request for review. Within one week subsequent to each workshop, submit draft workshop minutes for review and comment; submit final minutes incorporating any comments as necessary. The PCSI shall be responsible for facilitating the workshop and providing presentation material to all

participants. The PCSI and Contractor shall document the proceedings of the Coordination Workshops and submit along with all materials used at the workshop.

C. Workshops

1. Overall System Workshop: Within 30 days of award of contract or issuance of Notice-to-Proceed or as part of the Project construction kick-off meeting, the PCSI shall lead and facilitate a half a day workshop. The intent of this workshop is to review and discuss the main items of the project and highlight key issues including but not limited to:
 - a. Describe how the system is expected to operate. Provide copies of the control system architecture and P&IDS for use in describing the SCADA system elements, programs, and operational issues. Include discussion of the main processes, control strategies, flows, pressures, temperatures etc.
 - b. Describe all major mechanical, electrical and I&C equipment for the system. Point out any anticipated long-lead time items.
 - c. Describe the submittal review, RFI & change order processes with specified turn-around times.
 - d. Request any additional programming or graphical approaches from Engineer not previously requested.
 - e. Request Owner definition of non-process control ASD and pump/motor diagnostic data to be monitored as required per Section 40 61 96.
 - f. Receive Owner standard SCADA system database formats for use in creating HMI and PAC databases.
 - g. Receive data memory allocation table formats for integer and floating-point variables for use in data block transfers between PAC, HMI, and central SCADA systems.
2. Electrical, I&C and Mechanical Workshop: A minimum of two weeks prior to any submittals being sent in for review, the PCSI shall lead and facilitate a 4-hour workshop to review the preliminary Electrical, I&C and Mechanical submittals & schedules. The preliminary submittals should include the following:
 - a. Identify all equipment and instrumentation along with manufacturer & part/model numbers for each of the items.
 - b. Identify any long lead items with submittals that need to be prepared expeditiously.
 - c. Review overall Contractor's schedule and identify how the PCSI schedule submitted under the project workplan specified herein has been integrated into it. As specified, the PCSI schedule shall include all major milestones including submittals, field fabrication, testing, installation, field testing & training.
 - d. Review how the PCSI will phase the installation of the new equipment into the system while maintaining operations throughout the construction cycle. Describe panel installation, migration of control schemes, wiring modifications, and other requirements to implement the new control system without impacting existing system operations.
3. SCADA system programming workshop: A minimum of two weeks prior to any programming work lead and facilitate a 4-hour workshop that will be used to present the proposed PCSI programming approach and convey information to the PCSI about the Owner standards for controller programming, communications,

and other configuration performed under this Contract. PCSI shall present a summary of all new and modified control and monitoring elements included under this Contract. The following items would be covered as a minimum:

- a. Programming details
 - 1) Present sample draft HMI screens
 - 2) Present samples of screen navigation and the use of pop-up windows.
 - 3) Present tagging conventions to be used in HMI & PAC programs.
 - 4) Present method for data exchange including blocks of registers to be used for data transfers from PAC-to-PAC, PAC-to-HMI, RIO to PAC, third party digital platforms, etc.
 - 5) Present flow or logic diagrams for PAC programming.
 - 6) Present a list of new screens and reports to be developed under this Contract. Present a list of existing Owner screens and reports that will be modified under this Contract indicating the nature of the modifications to be implemented.
 - 7) Present proposed documentation for PAC programming including functional rung or flow chart documentation, page documentation, segment documentation, etc. all as specified herein.
 - 8) Present proposed documentation for HMI programming documentation including database addressing, scripts, report development, etc. all as specified herein.
 - 9) Present proposed method for implementing acquisition of Ethernet delivered data, graphical presentation of this data on the HMI screens, historical logging of this data, and forwarding of this data to the Owner central SCADA.
 - 10) Present programming scheme for ***** add special programming requirements for monitoring, communication, sequencing, etc. *****.
 - b. The PCSI shall use the P&IDs and Control Descriptions in Section 40 61 96 to demonstrate their understanding of and methods for system programming.
4. Interim Project Update Workshop: Midway through the programming effort and before scheduling of the Witness Test, PCSI shall conduct a 4-hour workshop. The intent of this workshop is for the PCSI to present project progress and highlight any significant changes in the approach. PCSI shall present:
 - a. A recap of how the system is expected to operate – include main flows, pressures, temperatures etc. using an updated process flow diagram.
 - b. Reviews of any changes to the Contract Documents of equipment, process, or services either in form or function.
 - c. Discussion of any outside/offsite influences that may affect completion of the programming effort.
 5. Project On-Site Testing, Training, Startup & Commissioning Workshop: Following successful completion of the PCSI Factory Testing but prior to startup of the main control panel and first set of pump control panels, PCSI shall conduct a 4-hour workshop. The intent of this workshop is for the PCSI and Contractor to provide a

review of the project schedule and project execution regarding testing, startup, and training as follows:

- a. On Site Testing: Summarize the schedule for each stage of field testing and identify the teams that will be responsible for the testing. The PCSI and Contractor shall prepare a summary of how all the testing will be performed, documented, and submitted. Draft test forms as specified herein shall be presented at the workshop.
 - b. Training: The PCSI and Contractor shall provide a listing of all the scheduled training that will take place with anticipated dates in accordance with these Specifications. The PCSI and Contractor shall also prepare a summary of personnel and qualifications of the individuals responsible for the training. Also indicate the target audience for the training. Any off-site training should be coordinated with the Owner staff at least 30 days prior to training.
 - c. Startup: The PCSI and Contractor shall coordinate startup and integrate into the startup plan, the Owner modifications. The PCSI and Contractor shall provide the draft startup plan including schedule for the startup and the personnel responsible for the startup. The plan shall be reviewed by and coordinated with the Owner operations, technical, and engineering staff to accommodate Owner operational requirements. The PCSI and Contractor shall be responsible for the preparation of all documentation that will be used for the startup testing and verification as specified herein.
 - d. Commissioning: Contractor shall review the Commissioning plan and provide status of required deliverables including but not limited to:
 - 1) O & M's
 - 2) Spare Parts
 - 3) Warranties
 - 4) Service Agreements
 - 5) Special equipment and tools
6. As required workshops: Five additional workshops shall be included for this project over and above the five workshops defined above.
- a. Topics and scheduling of these additional workshops shall be solely at the discretion of the Owner to address additional project requirements that may arise during construction.
 - b. Attendance at the additional workshops shall include at a minimum the Contractor, electrical subcontractor, PCSI, and Owner representatives.
 - c. Duration of each workshop shall be determined by the topic and discussion points but assume each additional workshop shall be 8 hours in length.
 - d. Specific personnel required for the workshops shall be determined based on the workshop topics to be addressed.
 - e. Owner shall provide a minimum of 2 weeks' notice to the PCSI of the need for the workshop after which the PCSI shall prepare a workshop agenda, coordinate workshop schedule, and facilitate the workshop.

1.12 FINAL SYSTEM DOCUMENTATION

- A. Submit operation and maintenance manuals covering instruction and maintenance on each type of equipment in accordance with the General Conditions.
- B. The instructions shall be bound in three-ring binders with drawings reduced or folded for inclusion and shall provide at least the following as a minimum.
 - 1. A comprehensive index.
 - 2. A complete "As Built" set of the PCSI approved hardware, software, and panel fabrication shop drawings.
 - 3. A complete list and data sheets of the equipment supplied, including serial numbers, ranges and pertinent data.
 - 4. Full specifications on each item.
 - 5. System schematic drawings "As Built" and "As-Left" details illustrating all components and final condition of each.
 - 6. Detailed service, maintenance and operation instructions for each item supplied.
 - 7. Special maintenance requirements particular to these systems shall be clearly defined, along with special calibration and test procedures.
 - 8. The operation instructions shall also incorporate a functional description of the entire system, with references to the systems schematic drawings and instructions.
 - 9. Complete parts lists with stock numbers and name, address and telephone number of the local Supplier.
- C. The PCSI's final documentation shall be new documentation written specifically for this project, but may include standard and modified standard documentation. Modifications to existing hardware or software manuals shall be made on the respective pages or inserted adjacent to the modified pages. All standard documentation furnished shall have all portions that apply clearly indicated. All portions that do not apply shall be lined out.
- D. The manuals shall contain all illustrations, detailed drawings, electrical schematics and instructions necessary for installing, operating and maintaining the equipment. The illustrated parts shall be numbered for identification. All information contained therein shall apply specifically to the equipment furnished and shall only include instructions that are applicable. All such figures shall be formatted within the printing of the page to form a legible, durable, and permanent reference book.
- E. Submit original software media of all software provided under this Contract. Submit original paper based or electronic documentation of all software provided. Submit license agreement information including serial numbers, license agreements, User Registration Numbers, etc. All software provided under this Contract shall be licensed to the Owner.
- F. The requirements for the PCSI's final documentation are as follows:
 - 1. As built documentation shall include information from submittals, as described in this Specification, updated to reflect the as-built system. Any errors in or modifications to the system resulting from the Factory and/or Functional Acceptance Tests shall be incorporated in this documentation.
 - 2. The Hardware Maintenance Documentation shall describe the detailed preventive and corrective procedures required to keep the system in good operating condition. Within the complete Hardware Maintenance Documentation, all hardware maintenance manuals shall make reference to appropriate diagnostics, where

applicable, and all necessary timing diagrams shall be included. A maintenance manual or a set of manuals shall be furnished for all delivered hardware, including peripherals. The Hardware Maintenance Documentation shall include, as a minimum, the following information:

- a. Operation Information - include a detailed description of how the equipment operates and a block diagram illustrating each major assembly in the equipment.
 - b. Preventative-Maintenance Instructions – These instructions shall include all applicable visual examinations, hardware testing and diagnostic routines and the adjustments necessary for periodic preventive maintenance of the System.
 - c. Corrective-Maintenance Instructions – Include guides for locating malfunctions down to the card-replacement level. These guides shall include adequate details for quickly and efficiently locating the cause of an equipment malfunction and shall state the probable source(s) of trouble, the symptoms, probable cause and instructions for remedying the malfunction.
 - d. Parts Information – Include the identification of each replaceable or field-repairable module. All parts shall be identified on a list in a drawing; the identification shall be of a level of detail sufficient for procuring any repairable or replaceable part. Cross-references between the PCSI's part number and manufacturer's part numbers shall be provided.
 - e. Manufacturer's contact information including name, local representative, phone numbers, web sites, and e-mail contact information.
3. The Software Maintenance documentation shall provide a detailed description of the entire software system. This documentation shall be sufficient for software maintenance and modification of the entire software system. The following items shall be included with the software maintenance documentation:
- a. System PCSI's User Manuals - All applicable software manuals developed by the PCSI for the application software.
 - b. Application/Custom Software Manuals - All software maintenance information not included in the system supplier's standard manuals. Each custom program developed specifically for the system shall include the following information as a minimum:
 - 1) Table of Contents
 - 2) Overview of the program
 - 3) Narrative describing specifically how the program works. All calculations, references to process I/O points and operator inputs should be mentioned and cross referenced to the logic diagrams or code.
 - c. Software Listings and Databases- Submit electronic files of well-annotated as-built programs for all software developed under this Contract. Programs shall reflect the as-built condition of the logic development submitted as part of the shop drawing review process. No portion of the submitted programming shall be password protected, or protected from viewing of the program, either online or offline. Where passwords are required for processor security, the passwords shall be provided to the Owner when the programs are submitted. Programs shall include, but not be limited to, the following:

- 1) All programming associated with the process programming and software configuration (e.g., system parameterization tables, build maps, disk maps, etc). Files shall be included for PACs, HMI application software, database applications, and all other equipment where specific programs or scripts were developed for this project.
- 2) Listings of all variables configured for and associated with the system.
- 3) Listing of all user-defined function blocks, scripting, or custom software developed specifically for the system. Listings shall reflect any changes made after the factory acceptance test.
- d. Warranty Documentation - The PCSI shall investigate, diagnose, repair, update and distribute all documentation of corrected deficiencies that become evident during the warranty period. All such documentation shall be submitted to Engineer within 30 days of solving the problem.
4. Provide Operator's Manuals for the system operators. These manuals shall be separately bound and shall contain all information necessary for the operator to operate the system. The manuals shall be written in non-technical terms and shall be organized for quick access to each detailed description of the operator's procedure. Manuals shall contain, but not be limited to, the following information:
 - a. A simple overview of the entire system indicating the function and purpose of each piece of equipment.
 - b. A detailed description of the operation of the HMI and Local Operator Panels including all appropriate displays, diagnostic screens, operating system, etc.
 - c. A detailed operational description of all control panels provided.
 - d. Step-by-step procedures for starting up or shutting down an individual component.
 - e. Step-by-step procedures for starting up and shutting down the entire system.
 - f. A comprehensive description of the operation and control of each plant process. All operator actions to these processes and the associated reaction described.
 - g. Operational description for operating HMI computer equipment and peripherals including printers, servers, workstations, UPS, etc. Description shall include procedures for typical maintenance and troubleshooting tasks.
 - h. A listing of all variable names with their respective English language point descriptions, memory address, and HMI graphic screen cross reference where the points can be found.
 - i. A complete glossary of terms.
 - j. Complete, step-by-step procedures for performing complete system or selected file backup and restoration.

1.13 CODES, INSPECTION AND FEES

- A. Equipment, materials and installation shall comply with the requirements of the local authority having jurisdiction.

- B. Obtain all necessary permits and pay all fees required for permits and inspections.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. General

1. Substitutions on functions or type of equipment specified will not be acceptable unless specifically noted. In order to ensure the interchangeability of parts, the maintenance of quality, the ease of interfacing between the various subsystems and the establishment of minimums with regard to ranges and accuracy, strict compliance with the above requirements shall be maintained. In order to ensure compatibility between all equipment, it shall be the responsibility of the PCSI to coordinate all interface requirements with mechanical and electrical systems and furnish any signal isolation devices that might be required.
2. To facilitate the Owner's future operation and maintenance, products shall be of the same major instrumentation manufacturer, with panel mounted devices of the same type and model as far as possible.
3. Schematic diagrams included in the Drawings are provided to show the functional intent of the required control circuits. Provide all relays, timers, terminal blocks, and accessories necessary to perform the functions shown and described. All control circuits shall be designed to power up in a normal functioning, non-alarm state, without operator intervention. Circuits that require manual intervention to resume normal operation after energization are not acceptable.

B. Physical

1. All instrumentation supplied shall be of the manufacturer's latest design and shall produce or be activated by signals that are established standards for the water industry.
2. Wetted components of the instrument for each installation shall be made of materials that are abrasion-resistant and corrosion-resistant to the process (e.g. sodium hydroxide, aluminum sulfate, cationic polyelectrolytes, etc.) as shown on the Drawings and as appropriate for the installation. The wetted components material(s) shall exhibit excellent or good abrasion and corrosion resistance to the chemical in service as rated by the material manufacturer. The final approval of material selection shall rest with the Engineer.
3. All electronic instrumentation shall be of the solid-state type and shall utilize either linear transmission signals of isolated 4 to 20 mA dc (milliampere direct current) or digital protocol where specified. However, signals between instruments within the same panel or cabinet may be 1-5V dc (volts direct current).
4. Outputs of equipment that are not of the standard signals as outlined, shall have the output immediately raised and/or converted to compatible standard signals for remote transmission. No zero-based signals will be allowed.
5. Provide mounting hardware and floor stands, wall brackets, or instrument racks. Fasteners for securing control panels and enclosures to walls and floors shall be either hot-dipped galvanized after fabrication or stainless steel. Provide stainless steel fasteners only in corrosive areas rated NEMA 4X. Provide and size anchors in accordance with Special Provisions and Division 5 as required per the seismic calculations. Provide minimum size anchor of 3/8-inch.
6. All indicators shall be linear in engineering process units unless otherwise noted.

7. All transmitters shall be provided with either integral indicators or conduit mounted indicators in process units, accurate to two percent or better.
8. Electronic equipment shall be of the manufacturer's latest design, utilizing printed circuitry and suitably coated to prevent contamination by dust, moisture and fungus. Solid state components shall be conservatively rated for their purpose, to assure optimum long-term performance and dependability over ambient atmosphere fluctuations and 0 to 100 percent relative humidity. The field mounted equipment and system components shall be designed for installation in dusty, humid and slightly corrosive service conditions.
9. All equipment, cabinets and devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, and shall consist of equipment models that are currently in production. All equipment provided shall be of modular construction and shall be capable of field expansion.
10. All electronic/digital equipment shall be provided with radio frequency interference protection.
11. Provide heating, cooling, dehumidifying, and filtering devices in control panel, enclosures, and cabinets as required to maintain internal ambient conditions within the most restrictive requirements of the equipment housed. Submit calculations as part of the panel fabrication submittal process verifying these requirements.

C. Electrical

1. Equipment shall be designed to operate on a 60 Hertz alternating current power source at a nominal 120 volts, plus or minus 10 percent, except where specifically noted. Where possible, all field instruments shall be 24 VDC loop powered as specified. Regulators and power supplies required for compliance with the above shall be provided between power supply and interconnected instrument loop or fieldbus link. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.
2. Materials and equipment used shall be U.L. approved wherever such approved equipment and materials are available.
3. Equipment shall be designed and constructed so that in the event of a power interruption, the equipment specified hereunder shall resume normal operation without manual resetting when power is restored unless otherwise noted.
4. All transmitter output signals shall include signal and power source isolation.

D. Nameplates

1. General: Provide nameplates as specified below unless specified otherwise in the detailed technical Specifications of related Sections of Division 40.
2. All panels and field instruments shall be supplied with suitable nameplates that identify the panel and individual devices as required.
3. Nameplates shall be a 3/32-inch thick, black and white, laminated Bakelite or Lamecoid with engraved inscriptions. The letters shall be white against a black background. Edges of the nameplates shall be beveled and smooth. Nameplates with chipped or rough edges will not be acceptable.
4. Orient nameplates to facilitate reading the device identifier from a cursory inspection. Do not mount nameplates behind or under equipment.
5. Nameplate fasteners and mounting shall be:

- a. Stainless steel wire, 0.048-inch diameter with stainless steel crimped clamps for hanging nameplates.
 - b. Stainless steel screws for cabinet mounted nameplates
6. Nameplates shall be as recommended by ISA Recommended Practice RP60.6.

2.2 LIGHTNING/SURGE PROTECTION

- A. General – Lightning/Surge protection shall be provided to protect the electronic instrumentation system from induced surges propagating along the signal and power supply lines from lightning, utility, or the internal plant electrical distribution system. The protection systems shall be such that the protective level shall not interfere with normal operation, but shall be lower than the instrument surge withstand level. Protection shall be maintenance free and self-restoring.
- B. Field Instrumentation Protection – Provide individual device protection for each field instrument mounted outside of the building or facility housing the control panel. Instruments mounted within the structure as the associated control panel shall not require surge protection. Instruments shall be housed in a suitable metallic case, properly grounded. Ground wires for all instrumentation device surge protectors shall be connected to a good earth ground. Where practical route each ground wire individually and insulated from each other. Device surge protectors shall be mounted within the instrument enclosure or a separate junction box coupled to the enclosure. Provide surge protection devices as manufactured by Phoenix Contact, Telecommunications Industries Inc.; or approved equal.
- C. Control Panel Power Supply – Provide protection of all 120 VAC instrument power supply lines. Source voltage to cabinets/panels regardless of location (indoor or outdoor), shall be protected by isolation transformers and surge suppressors. Provide gas tube surge suppressors or metal oxide varistors (MOVs) located at the point where the 120V source supply enters the enclosure. Install the surge device to be in strict compliance with the manufacturer's recommendation for maximum allowable circuit length between protective device and incoming circuit. Provide signal surge suppression devices as manufactured by Phoenix Contact or approved equal.
- D. Instrument 120 V Power Supply – Provide protection for 120 VAC power to all 4-wire field instruments (indoor or outdoor). Provide individual gas tube surge suppressors or metal oxide varistors (MOVs) located at the instrument end of the circuit. Provide signal surge suppression devices as manufactured by Phoenix Contact or approved equal.
- E. 4-20 mA Signal Lines and Non-Fiber Based Communication Circuits – Provide protection on all signal and communication circuits that leave a building or are routed external to a building. Provide gas tube surge arrestors, and Zener diode protectors. Circuit protection shall be provided at both ends of the signal or data highway lines within the control panel at one end and as close to the instruments or termination device as possible. Provide signal surge suppression devices as manufactured by Phoenix Contact or approved equal.
- F. Inductive Loads – Provide interposing relays on all process controller outputs or switches rated 100 VA or less that drive solenoid, coil, or motor loads. Refer to the detailed requirements for controller output protection in the detailed technical Specifications of the related Sections of Division 40. Provide interposing relays as manufactured by Phoenix Contact or approved equal.
- G. Radio Communication Equipment - To protect the radio equipment the Contractor shall provide surge protection devices mounted separately from the SCADA control panels in a separate enclosure. The enclosure shall house the grounded surge protector and include

terminal block and fittings as required to mount the devices. The surge protector shall be grounded per NEC Article 810. The surge protector shall be as specified in the detailed technical Specifications. At no time shall the surge protection device be mounted inside the same enclosure as the SCADA equipment.

2.3 TUBING AND FITTINGS

- A. All instrument air header takeoffs and branch connections less than 2-inches shall be 316 stainless steel.
- B. All instrument shut-off valves and associated fittings shall be supplied in accordance with the piping specifications and all instrument installation details. Fittings shall be Swagelok 316 stainless steel or approved equal. Valves and manifolds shall be Whitey 316 stainless steel or approved equal.
- C. All instrument tubing shall be fully annealed ASTM A269 Seamless 316 grade free of OD scratches having the following dimensional characteristics as required to fit the specific installation:
 - 1. 1/4-inches to 1/2-inches O.D. by 0.035 wall thickness.
- D. All process connections to instruments shall be annealed 1/2-inches O.D. stainless steel tubing, Type 316.
- E. All tubetrack shall be supported by stainless steel and installed as per manufacturer's installation instructions.

2.4 PANEL MARKINGS

- A. Each control panel shall be manufactured and assembled per the requirements of UL 508A. The complete assembly shall bear the UL label as an Industrial Control Panel as defined by UL 508A. If required for UL labeling, provide ground fault protective devices, isolation transformers, fuses and other equipment as necessary to achieve compliance with the UL standard. The Drawings do not detail all UL requirements.
- B. The UL label requirements shall apply to all panels except where enclosures contain instruments mounted through the enclosure walls or doors. In this case, panel construction shall meet all requirements of UL labeling as described above, but no UL label is required. This exception applies only if UL Recognized instruments or devices for the intended purpose are not made.

2.5 APPROVALS/CERTIFICATIONS

- A. Instruments for hazardous locations shall have Factory Mutual (FM), Canadian Standards Association (CSA), and CENELEC approvals and certifications as specified herein, as indicated on the Drawings, or where shown on the Instrument Schedule. The instrument specifications in Part 2 state the Class, Division, and gas groups for FM/CSA approval, followed in parenthesis by the CENELEC certification; however, instruments provided are only required to have the approval/certification stated above. The instrument shall have a stainless-steel tag identifying the relevant approval or certification.

2.6 UL REQUIREMENTS (UL 508A)

- A. All panel components shall be UL Listed for use in an industrial control panel assembly, and used for the specific purpose for which they are designed.
- B. All components that penetrate the panel shall be UL Listed to maintain the UL Type rating of the panel (Type 12, Type 4, Type 4X, etc.). If a NEMA 1 rated device is installed in the door of a NEMA 4X panel, the panel shall be de-rated to Type 1.
- C. Exhaust fans and louvers shall not be mounted on a control panel door containing operator devices.
- D. Non UL-Listed components may be used in a 120VAC circuit only if fed from an isolation transformer and a GFCI receptacle.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Equipment shall be installed in accordance with the manufacturer's instructions. The locations of equipment, transmitters, alarms and similar devices are diagrammatic only. Exact locations shall be as determined by the PCSI during development and fabrication of systems.
- B. The drawings indicate the intent and not the precise nature of the interconnection between the individual instruments. Exact nature of the final equipment interconnections shall be as determined by the PCSI during development and fabrication of systems.
- C. Where specific installation details are not specified or shown on the Drawings, installation recommendations from the equipment manufacturers or ISA shall be followed as applicable.
- D. The shield on each process instrumentation cable shall be continuous from source to destination and be grounded in accordance with the manufacturer's recommendations or as directed by the Engineer. In no case shall more than one ground point be employed for each shield.
- E. Once installed, remove lifting rings from cabinets/assemblies. Permanent plugs shall be provided for the holes of the same material and color as the cabinet.
- F. All work shall be executed in full accordance with codes and local rulings. Should any work be performed contrary to said rulings, ordinances and regulations, the Contractor shall bear full responsibility for such violations and assume all costs arising therefrom.
- G. Unless specifically shown in the Drawings, direct reading or electrical transmitting instrumentation shall not be mounted on process piping. Instrumentation shall be mounted on instrument racks or stands as detailed on the installation detail drawings. All instrumentation connections shall be provided with shutoff and drain valves. For differential pressure transmitters, valve manifolds for calibration, testing and blowdown service shall also be provided. For slurries, chemical or corrosive fluids, diaphragm seals with flushing connections shall be provided.
- H. All piping and tubing to and from field instrumentation shall be provided with necessary unions, calibrations and test tees, couplings, adaptors, and shut-off valves. Process tubing

shall be installed to slope from the instrument toward process for gas measurement service and from the process toward the instrument for liquid measurement service. Provide drain/vent valves or fittings at any process tubing points where the required slopes cannot be maintained.

- I. Provide local electrical shutoffs and disconnects for all 4-wire field instruments requiring 120 VAC power. Electrical disconnects shall be suitably rated disconnect switches or manual motor starters as specified under Division 26.
- J. Provide all brackets, hangers, and miscellaneous metals required for mounting of equipment. Mounting hardware shall be installed in a workmanlike manner and not interfere with any other equipment.
- K. The PCSI shall investigate each space in the building through which equipment must pass to reach its final location. If necessary, the PCSI shall be required to ship his/her material in sections sized to permit passing through restricted areas in the building. The PCSI shall also investigate, and make any field modifications to the allocated space for each cabinet, enclosure and panel to assure proper space and access (front, rear, side).
- L. The PCSI shall provide on-site service to oversee the installation, the placing and location of system components, their connections to the process equipment panels, cabinets and devices, subject to Engineer's approval. The PCSI shall certify that all field wiring for power and signal circuits are correctly done in accordance with best industry practice and provide for all necessary system grounding to insure a satisfactory functioning installation. The PCSI shall schedule and coordinate work under this Section with that of the electrical work specified under applicable Sections of Division 26.
- M. Provide sunshades for equipment mounted outdoors in direct sunlight. Sunshades shall include standoffs to allow air circulation around the cabinet. Orient equipment outdoors to face to the North or as required to minimize the impact of glare on LED, LCD, or other digital readouts.

3.2 TESTING

- A. Refer to Section 40 80 00. ***[insert the testing portion of 40 80 00 if that section is not included – best to include 40 80 00]***

3.3 TRAINING

- A. Refer to Section 40 80 00. ***[insert the training portion of 40 80 00 if that section is not included – best to include 40 80 00]***

END OF SECTION

APPENDIX 40 61 00-A

DRAFT OWNER PAC PROGRAMMING DESIGN AND CODING GUIDELINES

The Draft guidelines are included for reference only. The guideline is to be used as a reference for the PCSI documenting the Owner's expectations with respect to the design and coding of PAC programs developed for this Project. The PCSI shall acquire the latest version of the PAC Programming Design and Coding Guidelines following Notice to Proceed and prior to the first Coordination Workshop. Final programming details will be discussed and finalized with the Owner I&C staff at the Project Coordination Workshops as specified herein

INSERT APPENDIX D

INSERT APPENDIX G

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SECTION 40 61 93

I/O LIST

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. The I/O List is included for reference only. Providing all I/O necessary for a fully functioning system shall be the responsibility of the PCSI, based on the P&ID Drawings, Section 40 61 96 - Process Control Descriptions, auxiliary device requirements, and spare requirements as shown on the Drawings and specified in these Specifications.

1.02 RELATED WORK

1. Section 40 61 00 – Process Control System General Provisions
2. Section 40 61 96 – Process Control Descriptions
3. Section 40 63 00 – Control System Equipment
4. Section 40 67 00 – Control System Equipment Panels and Racks

1.03 SUBMITTALS

- A. As specified in Section 40 61 00.
- B. The PCSI shall revise the I/O List to include the I/O address, physical location (bus, rack, slot, and point), calibrated range in engineering units for analog points, and state values for Boolean points for each connected I/O and spare point.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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SECTION 40 63 00

CONTROL SYSTEM EQUIPMENT

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Provide programmable automation controllers (PACs), Human Machine Interface (HMI) workstations, network equipment, and other SCADA ancillary equipment where shown on the Drawings and as specified herein.
- B. The Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and Subcontractors to review all sections to insure a complete and coordinated project.
- C. Provide manufacturer's standard compatible software for all SCADA components where specified herein. All software provided shall match indicated Owner programming software standards
- D. All software provided shall be licensed to the Owner.
- E. Provide SCADA system configuration, integration, and programming for all SCADA components for a fully functioning and complete system. Provide one fully configured server node installed at the Pacheco Pumping Plant and one fully configured server node furnished to the Owner for installation at the Rinconada Water Treatment Plant by Owner staff.
- F. Furnish and install communication and networking equipment including fiber optic interfaces, network switches, firewalls, and other equipment as shown on the Drawings and specified herein. Provide communication and networking system configuration and establish reliable remote communication links between the PPP and the Owner's central SCADA facility located at the Rinconada WTP as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- 1. Section 27 13 23 – Fiber Optic Cables and Equipment
- 2. Section 40 61 00 – Process Control System General Provisions
- 3. Section 40 61 96 - Process Control Descriptions
- 4. Section 40 67 00 – Control System Equipment Panels and Racks

1.03 SUBMITTALS

- 1. Refer to Section 40 61 00

1.04 RELATED WORK PERFORMED BY OTHERS

1.05 REFERENCES

- 1. Refer to Section 40 61 00.

1.06 MAINTENANCE

- A. As a minimum, provide the following:
 - 1. One spare PAC Central Processor Module of each type provided under this Contract.
 - 2. 10% spare I/O card module of each type provided under this Contract.
 - 3. One spare PAC dedicated rack mounted communication card of each type provided under this Contract.
 - 4. One spare Ethernet network switch of each type provided under this Contract.
 - 5. One spare communication modem and other communication interface devices provided under this Contract.
 - 6. One spare power supply of each type provided under this Contract.
 - 7. Ten percent (10%) (minimum of 2) of each type of miscellaneous components, switches, lights, cable connectors, and other field replaceable system components provided under this Contract.
- B. All spare parts shall be carefully packed in cartons, labeled with indelible markings, and shall be adequately treated for a long period of storage. Complete ordering information including manufacturer's part number, part ordering information including manufacturer, part number, part name, and equipment name and number(s) for which the part is to be used shall be supplied with the required spare parts. The spare parts shall be delivered and stored in a location directed by Owner.

PART 2 - PRODUCTS

2.01 SCADA EQUIPMENT - GENERAL

- A. Equipment shall be designed to operate on a 60 Hertz alternating current power source at a nominal 120 volts, plus or minus 10 percent, except where specifically noted. Regulators and power supplies required for compliance with the above shall be provided. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.
- B. Materials and equipment used shall be UL approved wherever such approved equipment and materials are available.
- C. The system shall be designed and constructed to withstand the demands of real time process management and control.
- D. All equipment, cabinets and devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models that are currently in production. All equipment provided shall be of modular construction and shall be capable of field expansion through the installation of plug-in circuit cards or additional cabinets.
- E. All equipment furnished shall be designed and constructed so that in the event of power interruption, or temperatures outside the operational range, the systems specified hereunder shall go through an orderly shutdown with no loss of memory, and resume normal operation without manually resetting when power is restored.

- F. All software required to achieve the functionality described in the Specifications shall be provided. All software provided under this Contract shall be licensed to the Santa Clara Valley Water Owner. Coordinate with the Owner for licensing details and points of contact.
- G. Only software platforms and releases approved by the Owner for use shall be installed.

2.02 PROGRAMMABLE AUTOMATION CONTROLLERS (PACS) GENERAL

- A. The PACs shall communicate between the operator workstation and field mounted transducers, switches, controllers, and process actuators. Communications protocol shall be completely transparent to process operators at the HMI. The PAC shall be an intelligent microprocessor-based device that can collect data and process control functions. Communications with the operator workstation shall utilize the Ethernet 802.3 compliant data highway as shown in the Drawings. The PAC shall reside directly on the Ethernet data highway and communications shall be via a PAC chassis mounted Ethernet communications module as manufactured by the PAC manufacturer. Ancillary or third-party Ethernet equipment required to connect the PAC to the Ethernet data highway shall not be acceptable.
- B. All components of the PAC system shall be of commonly recognized industry standards and regularly sold for industrial installations. All components shall be assembled by the PAC manufacturer into standard structurally sound housings. All connecting cables, switches, and other operator-controlled devices shall be constructed so as to withstand, without damage, all normal use and handling. The PCSI as specified in Section 40 61 00 shall be responsible for installation of the equipment in control panel enclosures as specified in Section 40 67 00.
- C. The PAC system shall be of modular design with a plug-in processing unit, input/output cards, or assemblies. All components shall be marketed and supported by the one manufacturer. All necessary auxiliary cables, terminating components, connectors, and modules shall be included for a fully functioning PAC network system.
- D. Electrical supply voltage to the PAC shall be 24VDC. PAC system power supplies shall be fused for overload protection. Each PAC (including all I/O) shall be powered from the power supply and conditioning system as shown on the Drawings.
- E. The PAC shall be capable of stand-alone operation in the event of failure of the communication links.
- F. The PAC shall be a digital solid-state logic system capable of performing the same functions as conventional relays, timers, counters, and math functions. The PAC shall consist of a central processor unit, memory, input/output cards and racks, power suppliers, interconnecting cables, communication lines and other optional items as necessary to meet the functional requirements.
- G. All products shall be designed, manufactured, and tested in accordance with recognized industrial standards. All products shall have corrosion protection. All products shall have UL, CSA and FM approval. The PAC subsystems shall be approved for and adhere to the following agency and environmental specifications:
 - 1. Vibration: 3.5 mm Peak-to-Peak, 5-9 Hz: 1.0G, 9-150 \Hz, or 2G @ 10 ... 500Hz. The method of testing is to be based upon IEC 68-2-6 standards for vibration. The system is to be operational during and after testing.

2. Shock: 15G, 11 msec or operating rating of 30G for 11ms and storage rating of 50G for 11ms. The method of testing is to be based upon IEC 68-2-27 standards for shock. The system is to be operational during and after testing.
 3. Temperature: All PAC hardware shall operate at an ambient temperature of 0 to 60 degrees C (32 to 140 degrees F), with an ambient temperature rating for storage of - 40 to + 85 degrees C (- 40 to + 185 degrees F).
 4. Relative Humidity: The Programmable Controller hardware shall function continuously in the relative humidity range of 5% to 95% with no condensation.
 5. Noise Immunity: The Programmable Controller system shall be designed and tested to operate in the high electrical noise environment of an industrial plant as governed by the following regulations: IEEE 472, IEC 801, MILSTD 461B, IEC 255-4, NEMA ICS 2-230.40, and ANSI/IEEE C-37.90A-1978
- H. Modules are defined herein as devices which plug into a chassis and are keyed to allow installation in only one direction. The design must prohibit upside down insertion of the modules as well as safeguard against the insertion of a module into the wrong slot.
- I. In a single chassis system all system and signal power to the CPU and support modules shall be distributed on a single motherboard or backplane. No interconnecting wiring between these modules via plug-terminated jumpers shall be acceptable.
- J. All system modules, main and expansion chassis shall be designed to provide for free air flow convection cooling. No internal fans or other means of cooling, except heat sinks, shall be permitted.
- K. The programmable controller and all of the corresponding components within the family of controller products shall be by a company who regularly manufactures and services type of equipment. The manufacturer shall have a fully operational quality assurance and quality control program in place and shall comply with ISO9001 standards for "Quality Systems-Model for Quality Assurance in design/Development, Production, Installation, and Servicing".
- L. The manufacturer or its authorized representative shall provide complete technical support for all of the products. This shall include headquarters or local training, regional application centers, local or headquarters technical assistance and a "1-800" phone line.
- M. All major assemblies and sub-assemblies, circuit boards, and devices shall be identified using permanent labels or markings, each of which indicates the manufacturer's catalog number and a product manufacturing date code.

2.03 MAIN PROGRAMMABLE AUTOMATION CONTROLLERS (PACS)

- A. Provide main PAC platforms for installation in the Main Control Panel. Main PACs shall perform system wide control functions, network monitoring, hot-standby redundancy failover, and remote communications to the Owner's central SCADA facility.
- B. Provide a dual slot redundancy ready processor capable of 768KB of base program and data memory (7168MB after expansion), with at least 60 programmable channels suitable for process control.
- C. The Main PACs shall be xxx Series with yyy family I/O with features as specified, no equal to match the Owner's existing SCADA system hardware.

- D. Main PAC configuration software shall be IEC 61131-3 compliant programming software the same as specified herein for the Secondary PAC hardware.
- E. Major hardware components of the Main PAC platform shall include:
1. Central Processing Unit (CPU)
 2. Redundancy and Hot Back-Up Equipment
 3. Input/Output Modules
 4. Communications Modules
 5. Power Supply
- F. Central Processing Unit (CPU):
1. General
 - a. The CPU shall be at a minimum a 16-bit microprocessor that provides system timing and is responsible for scheduling I/O updates, with no user programming required to ensure discrete or analog update. It shall execute user relay ladder logic programs, communicate with intelligent I/O modules, and perform on-line diagnostics. The CPU shall consist of a single module which solves application logic, stores the application program, stores numerical values related to the application processes and logic, and interfaces to the I/O.
 - b. The CPU shall sample all the discrete and analog inputs and outputs including internal coils and registers and service special function modules every scan. The CPU shall process the I/O with user program (s) stored in memory, and then control the outputs based on the results of the logic operation.
 - c. The CPU shall execute the user program by rapidly scanning the program stored in user memory. Both logic and data word functions shall be executed in the order they appear in the user program. As each section or rung of logic is solved, the results shall be available to any of the following logic elements.
 - d. The CPU shall support an instruction to allow a decrease in scan time by skipping over parts of the program when directed. The CPU shall allow the PAC program to be broken into logic subroutines that execute only when called. The PAC shall allow analog and discrete points to be updated immediately within the scan as the discrete or analog value is called in the configuration program.
 - e. The CPU shall be a single printed circuit board utilizing surface mount technology. The CPU shall plug directly into the I/O base and require no additional wiring to the base, power supply, or the I/O.
 - f. Provide program execution and support remote or local programming. The CPU shall provide I/O scanning and peer to peer inter-processor communication to other PACs in the system and to peripheral support devices.
 - g. Store programs in either battery backed RAM or non-volatile flash memory. Data registers shall be stored in battery backed RAM.
 - h. Provide a battery backed integral real-time clock that can be accessed from the control program. The clock shall include registers for the time of day (year, month, day, hour, minute, second, and day of the week). The

real-time clock shall be easily synchronized with an external device such as a PC or another PAC as specified in Section 40 61 96. Permit changing program and data values while running without interrupting the process.

- i. Be based on 486, 586, or Pentium technology
- j. The PAC CPU family shall allow for user program transportability from one CPU model to another.

2. Capacity

- a. The CPU I/O capacity shall be up to 2048 I/O points, half of which may be analog.
- b. Processor performance shall be rated at least 10,280 instructions per millisecond at a program make up of 100 % Boolean instructions, and 10,070 instructions per millisecond at a program make up of 65% Boolean and 35% numerical.

3. Diagnostics

- a. Read the inputs, perform all system logic, conduct on-line diagnostics, and control the outputs. Diagnostics shall include memory checks, communications monitoring, I/O bus monitoring, watchdog timing, and user program validation.
- b. Monitor the health of every module in the local and Remote I/O backplanes. A single bit shall show the active or inactive state of each module. Information shall be accessible from the program, from programming software, or remotely from the HMI.
- c. The CPU shall perform on-line diagnostics that monitor the internal operation of the PAC. If a failure is detected, the CPU shall initiate system shutdown and fail-over if a failure occurs. The following at a minimum shall be monitored:
 - 1) Memory Failure
 - 2) Memory battery low
 - 3) CPU over temperature and general fault
 - 4) Communications port failure
 - 5) Scan time over run
 - 6) I/O failure
 - 7) Analog or special function I/O module failure
- d. All diagnostic information shall be accessible at the programming terminal which attaches to the CPU. A diagnostic page on the PAC programming terminal shall provide information which identifies the nature of the fault, the absolute memory or I/O address of the fault, and the date and time of occurrence of the fault.
- e. PAC diagnostic information shall be accessible to the host communications interfaces. Develop platform specific HMI PAC monitoring screens for presenting PAC diagnostics using the HMI configuration software specified herein to present the specific module failure to the operator.
- f. The CPU shall have LED indicators to show status such as PAC GOOD, PROGRAM RUN, and BATTERY GOOD. If any of the above conditions occur, provide an internal PAC diagnostic fail alarm contact output. The

CPU within the system shall perform internal diagnostic checking and give visual indication to the user by illuminating a "green" indicator when no fault is detected and a "red" indicator when a fault is detected.

4. Memory

- a. The CPU shall contain CMOS RAM program memory or compact flash storage memory. The CMOS RAM or compact flash memory shall have a battery backup system capable of retaining all memory for a minimum of three (3) months under load and shall require no external or special vents. The Compact flash memory shall have the capability to backup RAM contents during power failures. The backup battery shall be capable of being replaced without interruption of memory integrity or PAC process control functions.
- b. A visual indication of backup battery status shall be provided. In the event of low battery voltage, a visual indication and a low battery output alarm contact (for remote alarm) actuation shall be provided before battery failure.
- c. The program memory shall be sized as required to implement the functions specified plus a minimum of 10 words (16 bit) for each I/O provided as spare, but shall not be less than 48K bytes. The entire program memory shall be available for user program storage. Scratch pad and "housekeeping" programs shall be included in the calculation of the minimum memory size to ensure adequate spare memory is available to the Owner for future programming requirements.
- d. The PAC CPU memory shall consist of the following functional types of memory:
 - 1) Logic program memory
 - 2) Constant data memory
 - 3) Variable data memory
 - 4) Input/Output memory
 - 5) CPU status data memory
 - 6) I/O word memory
 - 7) User memory for compiled programs
- e. Memory allocation and combinations of logic and data storage up to the maximum limits shall be software configurable to match application requirements.

G. Communication Ports and Remote I/O Communications

1. Provide a minimum of three (3) PAC CPU rack resident communication ports for local programming, operator interface, and remote I/O operations. Provide ports integral to the CPU or additional manufacturer's standard add-on communication port modules as required to implement the network communication schemes as shown on the Drawings and specified herein.
2. The CPU shall be capable of communicating with a minimum of 14 remote PAC base locations at a combined distance of 2500 feet. The CPU shall automatically sample and update all local and remote I/O modules each scan cycle of the CPU.
3. The communication link between the CPU and any RIO chassis shall be via 20 AWG tinned copper communications grade cable as recommended by the PAC

manufacturer. For racks located on a link of less than 2500 cable feet, the speed of the communications link shall be greater than 230K baud with RIO scan rate of less than 5 milliseconds per RIO.

4. Diagnostic and equipment status information shall be available from each RIO similar to that specified for the CPU.
5. It shall be possible to communicate with remote I/O racks or other PACs via fiber optic cable by using chassis mounted fiber optic modems as shown on the Contract Documents.
6. The remote I/O system shall have available a remote input/output arrangement capable of operation at locations physically separated from the PAC CPU by up to 5,000 feet and as detailed on the Drawings.
7. Communication with the remote I/O arrangement shall be through cable as recommended by the PAC manufacturer and provided by the PCSI under this Contract.

H. Redundancy and Hot Back-Up Equipment

1. Provide two identical main PACs configured as a redundant pair. Redundant PACs shall be configured with separate PAC racks, power supplies, and network and I/O communication port so that any single device failure shall not compromise operation of the overall station PAC control. The PAC shall be supplied with all hardware and software recommended by the manufacturer as required for a completely operational redundant system as shown in the Drawings.
2. During normal operation, I/O status shall be updated in both primary and standby CPU's during each scan, but only the primary CPU shall write outputs. Critical data shall be continuously passed from the primary unit to the standby unit over an independent, dedicated high-performance data highway. All local and remote I/O shall maintain their last position until either communications is re-established or the remote I/O watchdog timer expires. Transfer from primary to standby shall occur in a bumpless, hot standby fashion and not disrupt any system processes.
3. Switch over between the primary PAC and the standby PAC shall occur within 50 milliseconds if any of the following conditions occur in the on-line unit:
 - a. Power failure
 - b. CPU fault
 - c. Communications module fault
 - d. Change in the on-line unit's mode from RUN to PROGRAM
4. System diagnostics and debugging tools shall be provided to assist in trouble shooting all redundancy equipment.
5. Redundancy shall be a standard feature of the PAC platform and accomplished using a minimum amount of application specific or custom user programming. The PCSI shall provide all PAC configuration necessary to implement the redundant system.

I. Input/Output Modules (I/O)

1. The I/O count and type shall be determined by the PCSI as required to implement the functions specified, as shown in 40 61 93 – I/O List, and including the requirement for active spares as noted below.
2. Each I/O drop or I/O location shall include 20 percent (minimum of two) active input points (both DI and AI) and 20 percent (minimum of two) active outputs points (both

DO and AO) for future use. The spares shall be the same type of I/O modules supplied for active process control functions. Spare output points that require the use of an external relay shall be supplied with the external relay. In addition to the indicated wired spares, provide additional 20% spare empty rack space (minimum of two slots) for installation of future I/O cards.

3. All installed unused points on all I/O modules shall be wired to terminal blocks and the termination cabinet in the sequential order that they occur on the I/O modules and in the order that the modules occur in the I/O rack. Termination of all spares at the end of the terminal strips or arbitrarily at random positions on the terminal strips shall not be acceptable. Spare analog input points shall each have their respective internal panel circuiting completed including a powered fuse and three terminal blocks reserved for future wiring and powering from panel powered loops. Refer also to Section 40 67 00.
4. I/O module usage shall comply with the following table unless noted otherwise:

a.	I/O Type	Module Type
b.	Analog input supply	4-20mA (individually isolated, remote power supply)
c.	Analog output supply	4-20mA (individually isolated, remote power supply)
d.	Discrete input	24VDC (individually isolated)
e.	Discrete output	24 VDC (with interposing relays)
5. Minimum isolation between input/output and logic voltage shall be 1500V RMS per NEMA standards via opto-isolation for AC I/O modules and 500 VDC for DC and Analog I/O modules.
6. Each I/O module shall have field replaceable fuse protection and blown fuse indicators.
7. The 24 VDC power for analog instrument loops shall be provided by the PCSI as a part of the system. The 24 VDC power supply shall be derived from the input power circuit to the PAC. The field side of the 24 VDC power sources(s) shall have individual fusing and provided with a readily visible, labeled blown fuse indicator. Grouped fusing is not acceptable.
8. Each 24 VDC type discrete output shall have an associated independent interposing relay located in the same control panel. 120 VAC or 24 VDC power for relay outputs shall be provided from the associated equipment control circuit (as applicable) or independently sourced or protected 120 VAC or 24 VDC power source. Interposing relays shall be as specified in Section 40 67 00.
9. Where multiple mechanical components are provided for process redundancy, their field connections to I/O modules shall be arranged such that the failure of a single I/O module will not disable all mechanical components of the redundant system (i.e., inputs for Pump No. 1 on one input card, inputs for Pump No. 2 on another input card).
10. I/O modules shall contain a maximum of 16 points per card.

J. PAC Rack Power Supply

1. The power supplies shall provide sufficient regulation and ripple control to assure that the rack resident devices being operated can operate within their required tolerances. Output over voltage and over current protective devices shall be provided with the power supply to protect devices from damage due to power

supply failure and to protect the power supply from damage due to external failure. Transformers shall have primary and secondary fuse protection.

2. Output over voltage and over current protective devices shall be provided.
3. The PAC shall have chassis mounted power supplies to power the chassis backplane, and provide power for the processor and applicable modules. Provide 24 VDC power supply module selected to power the final load requirements necessary for meeting the functional requirements as specified in the Contract Documents. Provide power supply with total wattage ratings suitable for the devices and modules specified plus an additional 50% capacity.
4. Provide power supplies as manufactured by Telemecanique/Modicon sized as required for the CPU and I/O module load requirements.
5. Refer to Section 40 67 00 for panel resident field instrument power supplies.

2.04 SECONDARY PROGRAMMABLE AUTOMATION CONTROLLERS

- A. Provide secondary PAC platforms for installation in each of the individual Pump Control Panels (PCP) and Backup Control Panel (BCP). Secondary PACs shall perform specific equipment or sub-system control functions and network communications. The secondary PACs shall be Telemecanique Modicon, Model No. M340, BMX P34 2020; no equal to match the Owner's existing SCADA system hardware.
- B. Secondary PAC configuration software shall be IEC 61131-3 compliant programming software the same as specified herein for the Main PAC hardware.
- C. Major hardware components of the Secondary PAC platform include:
 1. Central Processing Unit (CPU)
 2. Input/Output Modules
 3. Communications Modules
 4. Power Supply and Racks
- D. Central Processing Unit (CPU)
 1. Provide chassis mounted modular PAC designed for up to 1024 points of I/O with enhanced processing and communication options.
 2. Upon power loss, the PAC shall transfer internal RAM memory to flash memory before RAM powers down if the two programs are different. PACs with a battery backup for memory storage functions are not acceptable.
 3. Provide on board status lights to indicate the following at a minimum:
 - a. RUN lamp that illuminates when the program is executing
 - b. ERROR lamp that illuminates when a fault occurs in the processor
 - c. I/O lamp that illuminates upon an I/O failure or configuration fault
 - d. SER COM lamp that illuminates when activity is present on the serial port
 4. Processor shall be capable of being programmed via a USB port with a PC based programming terminal. The processor shall have an embedded web-server supplied with pre-developed and installed system diagnostics screens viewable from any commercial web-browser. The processor shall have an Ethernet port, USB terminal port, and a multi-protocol serial port capable of Modbus communication.

5. The processor shall accept an 8Mb SD memory card. This card shall be capable of storing, at a minimum application files, data files, PDF files, CAD files, Microsoft office files.
6. Provide processors with 4,096 Kb of internal user RAM with 3,584Kb of base program, constant, and symbol memory, 256K data memory for located and unlocated variables, and an 8M SD card for program backup. Processor shall have a USB terminal port, a multi-protocol serial port, and an Ethernet port. Processor Performance shall be rated at least 6,900 instructions per millisecond at a program make up of 65% Boolean and 35% numerical.
7. Programming cable: The PAC shall utilize a USB to Mini B cable for programming, compatible with those designed for downloading digital cameras to USB compatible PCs. Cable shall be available through most traditional retail stores serving the consumer electronics market.
8. Alarming: The PAC shall have a configurable alarming capability. Each alarm point can be configured to display an alphanumeric message in the alarm buffer. The alarm buffer can be displayed via a web page, or on an operator interface screen.
9. Connector cables:
 - a. Unterminated connector cables shall be available for interfacing to the discrete and analog cards. These cables shall have one end terminated to HE10 terminal block modules. The other end shall be unterminated to allow custom interface to panel devices. Provide 5 meter length minimum or as required for final PAC panel configuration.
 - b. Terminated connector cables shall be available for interfacing to the discrete and analog cards. These cables shall have one end terminated to interface to terminal block, or FCN socket, cards. The other end shall be terminated to interface with HE10 terminal block modules. Provide 5 meter length minimum or as required for final PAC panel configuration.

E. Input/Output Modules

1. The I/O count and type shall be determined by the PCSI as required to implement the functions specified, as shown in 40 61 93 – I/O List, and including the requirement for active spares as noted below.
2. Each I/O drop or I/O location shall include 20 percent (minimum of two) active input points (both DI and AI) and 20 percent (minimum of two) active outputs points (both DO and AO) for future use. The spares shall be the same type of I/O modules supplied for active process control functions. Spare output points that require the use of an external relay shall be supplied with the external relay. In addition to the indicated wired spares, provide additional 20% spare empty rack space (minimum of two slots) for installation of future I/O cards.
3. All installed unused points on all I/O modules shall be wired to terminal blocks and the termination cabinet in the sequential order that they occur on the I/O modules and in the order that the modules occur in the I/O rack. Termination of all spares at the end of the terminal strips or arbitrarily at random positions on the terminal strips shall not be acceptable. Spare analog input points shall each have their respective internal panel circuiting completed including a powered fuse and three terminal blocks reserved for future wiring and powering from panel powered loops. Refer also to Section 40 67 00.
4. Analog Inputs: Provide analog input cards with isolated channels. Provide maximum four channel cards, +/- 10V, 4-20mA.

5. Analog Outputs: Provide analog output cards with isolated channels. Provide maximum two channel cards, +/- 10V, 4-20mA output card.
6. Discrete Inputs: Provide discrete input cards with isolated channels. Provide maximum sixteen channel 24 VDC input card.
7. Discrete Outputs: Maximum eight channel 24VDC output card. Provide independent interposing relay located in the same control panel. 120 VAC or 24 VDC power for relay outputs shall be provided from the associated control circuit or independently sourced or protected 120 VAC or 24 VDC power source as required by the driven load. Interposing relays shall be as specified in Section 40 67 00.

F. Communications Modules

1. Communication Capabilities: The PAC shall directly support 10/100Mb Modbus TCP Ethernet, ASi V2 Master, Modbus, ASCII, CANopen, and Uni-Telway without the need for third party modules.
2. Ethernet capabilities:
 - a. 10/100MB Ethernet with connection via RJ45 connectors
 - b. A memory card slot for storage of memory
 - c. Built-in web server supplied with pre-developed and installed system diagnostics screens viewable from any commercial web-browser, and the capability of adding custom developed screens
 - d. Support for bus, star, ring and tree topographies with CSMA/CD methodology to access the network and prevent collisions
 - e. Modbus TCP messaging
 - f. Use of ARP and RARP protocols to insure IP and MAC address correspondence
 - g. Ability to be configured as a BootP client or DHCP server
 - h. Ability to be configured as Faulty Device Replacement (FDR) server. When configured, a replaced FDR compatible device will request the FDR server for parameters. When this request is received, the PAC will transfer the desired IP address and all configuration parameters to the replaced device.
 - i. Support of SNMP
 - j. Global Data support for up to 64 station in each group
 - k. I/O scanning that allows automatic read and write of remote I/O without programming over Modbus TCP protocol.

G. Power Supply and Racks

1. Power Supplies: The PAC shall have chassis mounted power supplies to power the chassis backplane, and provide power for the processor and applicable modules. Provide 24 VDC power supply module selected to power the final load requirements necessary for meeting the functional requirements as specified in the Contract Documents. Provide power supply with total wattage ratings suitable for the devices and modules specified plus an additional 50% capacity.
2. Chassis: The PAC shall have chassis to mount processors, power supplies, and other applicable cards. Provide 12 position configuration chassis. The chassis will be designed to mount individual enclosed cards. The chassis shall not have top,

bottom, or side walls. The cards will be secured to the chassis via a screw connection.

2.05 SMALL PROGRAMMABLE AUTOMATION CONTROLLERS

- A. Provide PAC platforms for installation as shown on the Drawings. PACs shall perform system wide control functions, network monitoring, and remote communications to the Owner's SCADA system.
- B. The PACs shall be Rockwell Automation MicroLogix, GE(ABB) Intelligent Platforms VersaMax, and I/O with features as specified, or equal.
- C. PAC configuration software shall be IEC 61131-3 compliant programming software.
- D. Major hardware components of the Main PAC platform shall include:
 - 1. Central Processing Unit (CPU)
 - 2. Input/Output Modules
 - 3. Communications Modules
 - 4. Power Supply

E. Central Processing Unit (CPU):

- 1. General
 - a. The CPU shall be at a minimum a 16-bit microprocessor that provides system timing and is responsible for scheduling I/O updates, with no user programming required to ensure discrete or analog update. It shall execute user relay ladder logic programs, communicate with intelligent I/O modules, and perform on-line diagnostics. The CPU shall consist of a single module which solves application logic, stores the application program, stores numerical values related to the application processes and logic, and interfaces to the I/O.
 - b. The CPU shall sample all the discrete and analog inputs and outputs including internal coils and registers and service special function modules every scan. The CPU shall process the I/O with user program (s) stored in memory, and then control the outputs based on the results of the logic operation.
 - c. The CPU shall execute the user program by rapidly scanning the program stored in user memory. Both logic and data word functions shall be executed in the order they appear in the user program. As each section or rung of logic is solved, the results shall be available to any of the following logic elements.
 - d. The CPU shall support an instruction to allow a decrease in scan time by skipping over parts of the program when directed. The CPU shall allow the PAC program to be broken into logic subroutines that execute only when called. The PAC shall allow analog and discrete points to be updated immediately within the scan as the discrete or analog value is called in the configuration program.
 - e. The CPU shall be a single printed circuit board utilizing surface mount technology. The CPU shall plug directly into the I/O base and require no additional wiring to the base, power supply, or the I/O.

- f. Provide program execution and support remote or local programming. The CPU shall provide I/O scanning and peer to peer inter-processor communication to other PACs in the system and to peripheral support devices.
- g. Store programs in either battery backed RAM or non-volatile flash memory. Data registers shall be stored in battery backed RAM.
- h. Provide a battery backed integral real-time clock that can be accessed from the control program. The clock shall include registers for the time of day (year, month, day, hour, minute, second, and day of the week). The real-time clock shall be easily synchronized with an external device such as a PC or another PAC as specified in Section 13305. Permit changing program and data values while running without interrupting the process.
- i. The PAC CPU family shall allow for user program transportability from one CPU model to another.
- j. The CPU module shall be an Allen Bradley model 1756-L62, no equal to match existing equipment.

2. Capacity

- a. The CPU I/O capacity shall be up to 1024 I/O points, half of which may be analog.
- b. Processor performance shall be rated at least 10,280 instructions per millisecond at a program make up of 100 % Boolean instructions, and 6,900 instructions per millisecond at a program make up of 65% Boolean and 35% numerical.

3. Diagnostics

- a. Read the inputs, perform all system logic, conduct on-line diagnostics, and control the outputs. Diagnostics shall include memory checks, communications monitoring, I/O bus monitoring, watchdog timing, and user program validation.
- b. Monitor the health of every module in the local and Remote I/O backplanes. A single bit shall show the active or inactive state of each module. Information shall be accessible from the program, from programming software, or remotely from the HMI.
- c. The CPU shall perform on-line diagnostics that monitor the internal operation of the PAC. If a failure is detected, the CPU shall initiate system shutdown and fail-over if a failure occurs. The following at a minimum shall be monitored:
 - 1) Memory Failure
 - 2) Memory battery low
 - 3) CPU over temperature and general fault
 - 4) Communications port failure
 - 5) Scan time over run
 - 6) I/O failure
 - 7) Analog or special function I/O module failure
- d. All diagnostic information shall be accessible at the programming terminal which attaches to the CPU. A diagnostic page on the PAC programming

terminal shall provide information which identifies the nature of the fault, the absolute memory or I/O address of the fault, and the date and time of occurrence of the fault.

- e. PAC diagnostic information shall be accessible to the host communications interfaces. Develop platform specific HMI PAC monitoring screens for presenting PAC diagnostics using the HMI configuration software specified herein to present the specific module failure to the operator.
- f. The CPU shall have LED indicators to show status such as **PAC GOOD, PROGRAM RUN, and BATTERY GOOD**. If any of the above conditions occur, provide an internal PAC diagnostic fail alarm contact output. The CPU within the system shall perform internal diagnostic checking and give positive visual indication for both normal (no fault) and fault conditions.

4. Memory

- a. The CPU shall contain CMOS RAM program memory or compact flash storage memory. The CMOS RAM or compact flash memory shall have a battery backup system capable of retaining all memory for a minimum of three (3) months under load and shall require no external or special vents. The Compact flash memory shall have the capability to backup RAM contents during power failures. The backup battery shall be capable of being replaced without interruption of memory integrity or PAC process control functions.
- b. A visual indication of backup battery status shall be provided. In the event of low battery voltage, a visual indication and a low battery output alarm contact (for remote alarm) actuation shall be provided before battery failure.
- c. The program memory shall be sized as required to implement the functions specified plus a minimum of 10 words (16 bit) for each I/O provided as spare, but shall not be less than 48K bytes. The entire program memory shall be available for user program storage. Scratch pad and "housekeeping" programs shall be included in the calculation of the minimum memory size to ensure adequate spare memory is available to the City for future programming requirements.
- d. The PAC CPU memory shall consist of the following functional types of memory:
 - 1) Logic program memory
 - 2) Constant data memory
 - 3) Variable data memory
 - 4) Input/Output memory
 - 5) CPU status data memory
 - 6) I/O word memory
 - 7) User memory for compiled programs
- e. Memory allocation and combinations of logic and data storage up to the maximum limits shall be software configurable to match application requirements.

F. Communication Ports and Remote I/O Communications

1. Provide a CPU resident dedicated communication ports for local programming. Provide additional Ethernet interface modules if required for local programming, operator interface, or remote communications as shown on the Drawings. Provide ports integral to the CPU or additional manufacturer's standard rack resident add-on communication modules as required to implement the network communication schemes as shown on the Drawings and specified herein.
2. The CPU shall be capable of communicating with a minimum of **40 remote PAC base locations at a combined distance of 2500 feet.** The CPU shall automatically sample and update all local and remote I/O modules each scan cycle of the CPU.
3. The communication link between the CPU and any RIO chassis shall be via EtherNet. Contractor shall provide trunk cables, drop cables, taps, and terminators necessary for a complete and operational RIO network as shown on the Drawings.
4. Diagnostic and equipment status information shall be available from each RIO similar to that specified for the CPU.
5. It shall be possible to communicate with remote I/O racks or other PACs via fiber optic cable by using chassis mounted fiber optic modems as shown on Contract Documents.
6. Communication with the remote I/O arrangement shall be through cable as recommended by the PAC manufacturer and provided by the PCSI under this Contract.
7. Ethernet communications bridge modules shall match existing equipment.

G. Input/Output Modules (I/O)

1. The I/O count and type shall be as indicated on the Contract Documents of Section 40 61 93 – I/O List and as shown on the Drawings, including the specified requirements for active spares as noted below.
2. Each I/O drop or I/O location shall include 20 percent (minimum of two) active input points (both DI and AI) and 20 percent (minimum of two) active outputs points (both DO and AO) for future use. The spares shall be the same type of I/O modules supplied for active process control functions. Spare output points that require the use of an external relay shall be supplied with the external relay. In addition to the indicated wired spares, provide additional 20% spare empty rack space (minimum of two slots) for installation of future I/O cards.
3. All installed unused points on all I/O modules shall be wired to terminal blocks and the termination cabinet in the sequential order that they occur on the I/O modules and in the order that the modules occur in the I/O rack. Termination of all spares at the end of the terminal strips or arbitrarily at random positions on the terminal strips shall not be acceptable. Spare analog input points shall each have their respective internal panel circuiting completed including a powered fuse, disconnecting terminal block, three feed through terminal blocks, and a grounded terminal block for the signal shield. Refer also to Section 40 67 00.
4. I/O module usage shall comply with the following table unless noted otherwise:

	I/O Type	Module Type
a.	Analog input	4-20mA (individually isolated)
b.	Analog output	4-20mA (individually isolated)
c.	Discrete input	120VAC (individually isolated)
d.	Discrete output	120VAC (grouped with interposing relays)

5. Minimum isolation between input/output and logic voltage shall be 1500V RMS per NEMA standards via opto-isolation for AC I/O modules and 500 VDC for DC and Analog I/O modules.
6. Each I/O module shall have field replaceable fuse protection and blown fuse indicators.
7. The 24 VDC power for analog instrument loops shall be provided by the PCSI as a part of the system. The field side of the 24 VDC power sources(s) shall have individual fusing and provided with a readily visible, labeled blown fuse indicator. Grouped fusing is not acceptable.
8. Each 120VAC type discrete output shall have an associated independent interposing relay located in the same control panel. 120 VAC for relay outputs shall be provided from the control panel UPS circuit. Interposing relays shall be as specified in Section 40 67 00.
9. Where multiple mechanical components are provided for process redundancy, their field connections to I/O modules shall be arranged such that the failure of a single I/O module will not disable all mechanical components of the redundant system (i.e., inputs for Pump No. 1 on one input card, inputs for Pump No. 2 on another input card).
10. Analog Inputs: Provide analog input cards with 8-point isolated 4-20mA channels and minimum 12-bit resolution. Analog input modules shall match existing equipment.
11. Analog Outputs: Provide analog output cards with 4-point isolated 4-20mA channels and minimum 12-bit resolution. Analog output modules shall match existing equipment.
12. Discrete Inputs: Provide discrete input cards with 16-point isolated 120VAC inputs. Discrete input modules shall match existing equipment.
13. Discrete Outputs: Provide discrete input cards with 16-point (2 groups of 8) 120VAC outputs. Each discrete output shall be wired to an individual interposing relays with relay contacts wired to field interface terminal blocks. Discrete output modules shall match existing equipment.

H. PAC Rack Power Supply

1. The power supplies shall provide sufficient regulation and ripple control to assure that the rack resident devices being operated can operate within their required tolerances. Output over voltage and over current protective devices shall be provided with the power supply to protect devices from damage due to power supply failure and to protect the power supply from damage due to external failure. Transformers shall have primary and secondary fuse protection.
2. Output over voltage and over current protective devices shall be provided.
3. The PAC shall have chassis mounted power supplies to power the chassis backplane, and provide power for the processor and applicable modules. Provide power supply module selected to power the final load requirements necessary for meeting the functional requirements as specified in the Contract Documents. Provide power supply with total wattage ratings suitable for the devices and modules specified plus an additional 50% capacity.
4. PAC power supply modules shall be powered from the control panel UPS circuit.
5. Provide power supplies sized as required for the CPU and I/O module load requirements. Manufacturer?
6. Refer to Section 40 67 00 for panel resident field instrument power supplies.

2.06 MEDIUM PROGRAMMABLE AUTOMATION CONTROLLERS

- A. Provide PAC platforms for installation as shown on the Drawings. PACs shall perform system wide control functions, network monitoring, and remote communications to the City's SCADA system.
- B. The PACs shall be Rockwell Automation CompactLogix 1768-L4x series, Schneider Automation M340, GE (ABB) Intelligent Platforms RXi, and I/O with features as specified, or equal.
- C. PAC configuration software shall be IEC 61131-3 compliant programming software.
- D. Major hardware components of the Main PAC platform shall include:
 - 1. Central Processing Unit (CPU)
 - 2. Input/Output Modules
 - 3. Communications Modules
 - 4. Power Supply
- E. Central Processing Unit (CPU):
 - 1. General
 - a. The CPU shall be at a minimum a 16-bit microprocessor that provides system timing and is responsible for scheduling I/O updates, with no user programming required to ensure discrete or analog update. It shall execute user relay ladder logic programs, communicate with intelligent I/O modules, and perform on-line diagnostics. The CPU shall consist of a single module which solves application logic, stores the application program, stores numerical values related to the application processes and logic, and interfaces to the I/O.
 - b. The CPU shall sample all the discrete and analog inputs and outputs including internal coils and registers and service special function modules every scan. The CPU shall process the I/O with user program (s) stored in memory, and then control the outputs based on the results of the logic operation.
 - c. The CPU shall execute the user program by rapidly scanning the program stored in user memory. Both logic and data word functions shall be executed in the order they appear in the user program. As each section or rung of logic is solved, the results shall be available to any of the following logic elements.
 - d. The CPU shall support an instruction to allow a decrease in scan time by skipping over parts of the program when directed. The CPU shall allow the PAC program to be broken into logic subroutines that execute only when called. The PAC shall allow analog and discrete points to be updated immediately within the scan as the discrete or analog value is called in the configuration program.
 - e. The CPU shall be a single printed circuit board utilizing surface mount technology. The CPU shall plug directly into the I/O base and require no additional wiring to the base, power supply, or the I/O.

- f. Provide program execution and support remote or local programming. The CPU shall provide I/O scanning and peer to peer inter-processor communication to other PACs in the system and to peripheral support devices.
 - g. Store programs in either battery backed RAM or non-volatile flash memory. Data registers shall be stored in battery backed RAM.
 - h. Provide a battery backed integral real-time clock that can be accessed from the control program. The clock shall include registers for the time of day (year, month, day, hour, minute, second, and day of the week). The real-time clock shall be easily synchronized with an external device such as a PC or another PAC as specified in Section 13305. Permit changing program and data values while running without interrupting the process.
 - i. The PAC CPU family shall allow for user program transportability from one CPU model to another.
 - j. The CPU module shall match existing equipment.
2. Capacity
- a. The CPU I/O capacity shall be up to 2048 I/O points, half of which may be analog.
 - b. Processor performance shall be rated at least 10,280 instructions per millisecond at a program make up of 100 % Boolean instructions, and 10,070 instructions per millisecond at a program make up of 65% Boolean and 35% numerical.
3. Diagnostics
- a. Read the inputs, perform all system logic, conduct on-line diagnostics, and control the outputs. Diagnostics shall include memory checks, communications monitoring, I/O bus monitoring, watchdog timing, and user program validation.
 - b. Monitor the health of every module in the local and Remote I/O backplanes. A single bit shall show the active or inactive state of each module. Information shall be accessible from the program, from programming software, or remotely from the HMI.
 - c. The CPU shall perform on-line diagnostics that monitor the internal operation of the PAC. If a failure is detected, the CPU shall initiate system shutdown and fail-over if a failure occurs. The following at a minimum shall be monitored:
 - 1) Memory Failure
 - 2) Memory battery low
 - 3) CPU over temperature and general fault
 - 4) Communications port failure
 - 5) Scan time over run
 - 6) I/O failure
 - 7) Analog or special function I/O module failure
 - d. All diagnostic information shall be accessible at the programming terminal which attaches to the CPU. A diagnostic page on the PAC programming terminal shall provide information which identifies the nature of the fault,

the absolute memory or I/O address of the fault, and the date and time of occurrence of the fault.

- e. PAC diagnostic information shall be accessible to the host communications interfaces. Develop platform specific HMI PAC monitoring screens for presenting PAC diagnostics using the HMI configuration software specified herein to present the specific module failure to the operator.
- f. The CPU shall have LED indicators to show status such as **PAC GOOD, PROGRAM RUN, and BATTERY GOOD**. If any of the above conditions occur, provide an internal PAC diagnostic fail alarm contact output. The CPU within the system shall perform internal diagnostic checking and give positive visual indication for both normal (no fault) and fault conditions.

4. Memory

- a. The CPU shall contain CMOS RAM program memory or compact flash storage memory. The CMOS RAM or compact flash memory shall have a battery backup system capable of retaining all memory for a minimum of three (3) months under load and shall require no external or special vents. The Compact flash memory shall have the capability to backup RAM contents during power failures. The backup battery shall be capable of being replaced without interruption of memory integrity or PAC process control functions.
- b. A visual indication of backup battery status shall be provided. In the event of low battery voltage, a visual indication and a low battery output alarm contact (for remote alarm) actuation shall be provided before battery failure.
- c. The program memory shall be sized as required to implement the functions specified plus a minimum of **10 words (16 bit)** for each I/O provided as spare, but shall not be less than **48K bytes**. The entire program memory shall be available for user program storage. Scratch pad and "housekeeping" programs shall be included in the calculation of the minimum memory size to ensure adequate spare memory is available to the City for future programming requirements.
- d. The PAC CPU memory shall consist of the following functional types of memory:
 - 1) Logic program memory
 - 2) Constant data memory
 - 3) Variable data memory
 - 4) Input/Output memory
 - 5) CPU status data memory
 - 6) I/O word memory
 - 7) User memory for compiled programs
- e. Memory allocation and combinations of logic and data storage up to the maximum limits shall be software configurable to match application requirements.

F. Communication Ports and Remote I/O Communications

1. Provide a CPU resident dedicated communication ports for local programming. Provide additional Ethernet interface modules if required for local programming, operator interface, or remote communications as shown on the Drawings. Provide ports integral to the CPU or additional manufacturer's standard rack resident add-on communication modules as required to implement the network communication schemes as shown on the Drawings and specified herein.
2. **The CPU shall be capable of communicating with a minimum of 40 remote PAC base locations at a combined distance of 2500 feet.** The CPU shall automatically sample and update all local and remote I/O modules each scan cycle of the CPU.
3. The communication link between the CPU and any RIO chassis shall be via Ethernet. Contractor shall provide trunk cables, drop cables, taps, and terminators necessary for a complete and operational RIO network as shown on the Drawings.
4. Diagnostic and equipment status information shall be available from each RIO similar to that specified for the CPU.
5. It shall be possible to communicate with remote I/O racks or other PACs via fiber optic cable by using chassis mounted fiber optic modems as shown on the Drawings specified herein.
6. Communication with the remote I/O arrangement shall be through cable as recommended by the PAC manufacturer and provided by the PCSI under this Contract.
7. **Ethernet communications bridge modules shall match existing equipment.**

G. Input/Output Modules (I/O)

1. The I/O count and type shall be as indicated on the Contract Documents of Section 40 61 93 – I/O List and as shown on the Drawings, including the specified requirements for active spares as noted below.
2. Each I/O drop or I/O location shall include 20 percent (minimum of two) active input points (both DI and AI) and 20 percent (minimum of two) active outputs points (both DO and AO) for future use. The spares shall be the same type of I/O modules supplied for active process control functions. Spare output points that require the use of an external relay shall be supplied with the external relay. In addition to the indicated wired spares, provide additional 20% spare empty rack space (minimum of two slots) for installation of future I/O cards.
3. All installed unused points on all I/O modules shall be wired to terminal blocks and the termination cabinet in the sequential order that they occur on the I/O modules and in the order that the modules occur in the I/O rack. Termination of all spares at the end of the terminal strips or arbitrarily at random positions on the terminal strips shall not be acceptable. Spare analog input points shall each have their respective internal panel circuiting completed including a powered fuse, disconnecting terminal block, three feed through terminal blocks, and a grounded terminal block for the signal shield. Refer also to Section 40 67 00.
4. I/O module usage shall comply with the following table unless noted otherwise:

	I/O Type	Module Type
a.	Analog input	4-20mA (individually isolated)
b.	Analog output	4-20mA (individually isolated)
c.	Discrete input	120VAC (individually isolated)
d.	Discrete output	120VAC (grouped with interposing relays)

5. Minimum isolation between input/output and logic voltage shall be 1500V RMS per NEMA standards via opto-isolation for AC I/O modules and 500 VDC for DC and Analog I/O modules.
6. Each I/O module shall have field replaceable fuse protection and blown fuse indicators.
7. The 24 VDC power for analog instrument loops shall be provided by the PCSI as a part of the system. The field side of the 24 VDC power sources(s) shall have individual fusing and provided with a readily visible, labeled blown fuse indicator. Grouped fusing is not acceptable.
8. Each 120VAC type discrete output shall have an associated independent interposing relay located in the same control panel. 120 VAC for relay outputs shall be provided from the control panel UPS circuit. Interposing relays shall be as specified in Section 40 67 00.
9. Where multiple mechanical components are provided for process redundancy, their field connections to I/O modules shall be arranged such that the failure of a single I/O module will not disable all mechanical components of the redundant system (i.e., inputs for Pump No. 1 on one input card, inputs for Pump No. 2 on another input card).
10. Analog Inputs: Provide analog input cards with 8-point isolated 4-20mA channels and minimum 12-bit resolution. Analog input modules shall match existing equipment.
11. Analog Outputs: Provide analog output cards with 4-point isolated 4-20mA channels and minimum 12-bit resolution. Analog output modules shall match existing equipment.
12. Discrete Inputs: Provide discrete input cards with 16-point isolated 120VAC inputs. Discrete input modules shall match existing equipment.
13. Discrete Outputs: Provide discrete input cards with 16-point (2 groups of 8) 120VAC outputs. Each discrete output shall be wired to an individual interposing relays with relay contacts wired to field interface terminal blocks. Discrete output modules shall match existing equipment.

H. PAC Rack Power Supply

1. The power supplies shall provide sufficient regulation and ripple control to assure that the rack resident devices being operated can operate within their required tolerances. Output over voltage and over current protective devices shall be provided with the power supply to protect devices from damage due to power supply failure and to protect the power supply from damage due to external failure. Transformers shall have primary and secondary fuse protection.
2. Output over voltage and over current protective devices shall be provided.
3. The PAC shall have chassis mounted power supplies to power the chassis backplane, and provide power for the processor and applicable modules. Provide power supply module selected to power the final load requirements necessary for meeting the functional requirements as specified in the Contract Documents. Provide power supply with total wattage ratings suitable for the devices and modules specified plus an additional 50% capacity.
4. PAC power supply modules shall be powered from the control panel UPS circuit.
5. Provide power supplies sized as required for the CPU and I/O module load requirements. Manufacturer?
6. Refer to Section 40 67 00 for panel resident field instrument power supplies.

2.07 LARGE PROGRAMMABLE AUTOMATION CONTROLLERS

- A. Provide PAC platforms for installation as shown on the Drawings. PACs shall perform system wide control functions, network monitoring, and remote communications to the City's SCADA system.
- B. The PACs shall be Rockwell Automation ControlLogix Units 1756-L7x series, Schneider Automation Quantum Unity, GE (ABB) Intelligent Platforms RX3i, series I/O with features as specified, or equal.
- C. PAC configuration software shall be IEC 61131-3 compliant programming software.
- D. Major hardware components of the Main PAC platform shall include:
 - 1. Central Processing Unit (CPU)
 - 2. Input/Output Modules
 - 3. Communications Modules
 - 4. Power Supply
- E. Central Processing Unit (CPU):
 - 1. General
 - a. The CPU shall be at a minimum a 16-bit microprocessor that provides system timing and is responsible for scheduling I/O updates, with no user programming required to ensure discrete or analog update. It shall execute user relay ladder logic programs, communicate with intelligent I/O modules, and perform on-line diagnostics. The CPU shall consist of a single module which solves application logic, stores the application program, stores numerical values related to the application processes and logic, and interfaces to the I/O.
 - b. The CPU shall sample all the discrete and analog inputs and outputs including internal coils and registers and service special function modules every scan. The CPU shall process the I/O with user program (s) stored in memory, and then control the outputs based on the results of the logic operation.
 - c. The CPU shall execute the user program by rapidly scanning the program stored in user memory. Both logic and data word functions shall be executed in the order they appear in the user program. As each section or rung of logic is solved, the results shall be available to any of the following logic elements.
 - d. The CPU shall support an instruction to allow a decrease in scan time by skipping over parts of the program when directed. The CPU shall allow the PAC program to be broken into logic subroutines that execute only when called. The PAC shall allow analog and discrete points to be updated immediately within the scan as the discrete or analog value is called in the configuration program.
 - e. The CPU shall be a single printed circuit board utilizing surface mount technology. The CPU shall plug directly into the I/O base and require no additional wiring to the base, power supply, or the I/O.

- f. Provide program execution and support remote or local programming. The CPU shall provide I/O scanning and peer to peer inter-processor communication to other PACs in the system and to peripheral support devices.
 - g. Store programs in either battery backed RAM or non-volatile flash memory. Data registers shall be stored in battery backed RAM.
 - h. Provide a battery backed integral real-time clock that can be accessed from the control program. The clock shall include registers for the time of day (year, month, day, hour, minute, second, and day of the week). The real-time clock shall be easily synchronized with an external device such as a PC or another PAC as specified in Section 13305. Permit changing program and data values while running without interrupting the process.
 - i. The PAC CPU family shall allow for user program transportability from one CPU model to another.
 - j. The CPU module shall match existing equipment.
2. Capacity
- a. The CPU I/O capacity shall be up to 62,000 I/O points, half of which may be analog.
 - b. Processor performance shall be rated at least 10,280 instructions per millisecond at a program make up of 100 % Boolean instructions, and 10,070 instructions per millisecond at a program make up of 65% Boolean and 35% numerical.
3. Diagnostics
- a. Read the inputs, perform all system logic, conduct on-line diagnostics, and control the outputs. Diagnostics shall include memory checks, communications monitoring, I/O bus monitoring, watchdog timing, and user program validation.
 - b. Monitor the health of every module in the local and Remote I/O backplanes. A single bit shall show the active or inactive state of each module. Information shall be accessible from the program, from programming software, or remotely from the HMI.
 - c. The CPU shall perform on-line diagnostics that monitor the internal operation of the PAC. If a failure is detected, the CPU shall initiate system shutdown and fail-over if a failure occurs. The following at a minimum shall be monitored:
 - 1) Memory Failure
 - 2) Memory battery low
 - 3) CPU over temperature and general fault
 - 4) Communications port failure
 - 5) Scan time over run
 - 6) I/O failure
 - 7) Analog or special function I/O module failure
 - d. All diagnostic information shall be accessible at the programming terminal which attaches to the CPU. A diagnostic page on the PAC programming terminal shall provide information which identifies the nature of the fault,

the absolute memory or I/O address of the fault, and the date and time of occurrence of the fault.

- e. PAC diagnostic information shall be accessible to the host communications interfaces. Develop platform specific HMI PAC monitoring screens for presenting PAC diagnostics using the HMI configuration software specified herein to present the specific module failure to the operator.
- f. The CPU shall have LED indicators to show status such as **PAC GOOD, PROGRAM RUN, and BATTERY GOOD**. If any of the above conditions occur, provide an internal PAC diagnostic fail alarm contact output. The CPU within the system shall perform internal diagnostic checking and give positive visual indication for both normal (no fault) and fault conditions.

4. Memory

- a. The CPU shall contain CMOS RAM program memory or compact flash storage memory. The CMOS RAM or compact flash memory shall have a battery backup system capable of retaining all memory for a minimum of three (3) months under load and shall require no external or special vents. The Compact flash memory shall have the capability to backup RAM contents during power failures. The backup battery shall be capable of being replaced without interruption of memory integrity or PAC process control functions.
- b. A visual indication of backup battery status shall be provided. In the event of low battery voltage, a visual indication and a low battery output alarm contact (for remote alarm) actuation shall be provided before battery failure.
- c. The program memory shall be sized as required to implement the functions specified plus a minimum of **10 words (16 bit)** for each I/O provided as spare, but shall not be less than **48K bytes**. The entire program memory shall be available for user program storage. Scratch pad and "housekeeping" programs shall be included in the calculation of the minimum memory size to ensure adequate spare memory is available to the City for future programming requirements.
- d. The PAC CPU memory shall consist of the following functional types of memory:
 - 1) Logic program memory
 - 2) Constant data memory
 - 3) Variable data memory
 - 4) Input/Output memory
 - 5) CPU status data memory
 - 6) I/O word memory
 - 7) User memory for compiled programs
- e. Memory allocation and combinations of logic and data storage up to the maximum limits shall be software configurable to match application requirements.

F. Communication Ports and Remote I/O Communications

1. Provide a CPU resident dedicated communication ports for local programming. Provide additional Ethernet interface modules if required for local programming, operator interface, or remote communications as shown on the Drawings. Provide ports integral to the CPU or additional manufacturer's standard rack resident add-on communication modules as required to implement the network communication schemes as shown on the Drawings and specified herein.
2. **The CPU shall be capable of communicating with a minimum of 40 remote PAC base locations at a combined distance of 2500 feet.** The CPU shall automatically sample and update all local and remote I/O modules each scan cycle of the CPU.
3. The communication link between the CPU and any RIO chassis shall be via Ethernet. Contractor shall provide trunk cables, drop cables, taps, and terminators necessary for a complete and operational RIO network as shown on the Drawings.
4. Diagnostic and equipment status information shall be available from each RIO similar to that specified for the CPU.
5. It shall be possible to communicate with remote I/O racks or other PACs via fiber optic cable by using chassis mounted fiber optic modems as shown on the Drawings specified herein.
6. Communication with the remote I/O arrangement shall be through cable as recommended by the PAC manufacturer and provided by the PCSI under this Contract.
7. EtherNet communications bridge modules shall match existing equipment.

G. Input/Output Modules (I/O)

1. The I/O count and type shall be as indicated on the Contract Documents of Section 40 61 93 – I/O List and as shown on the Drawings, including the specified requirements for active spares as noted below.
2. Each I/O drop or I/O location shall include 20 percent (minimum of two) active input points (both DI and AI) and 20 percent (minimum of two) active outputs points (both DO and AO) for future use. The spares shall be the same type of I/O modules supplied for active process control functions. Spare output points that require the use of an external relay shall be supplied with the external relay. In addition to the indicated wired spares, provide additional 20% spare empty rack space (minimum of two slots) for installation of future I/O cards.
3. All installed unused points on all I/O modules shall be wired to terminal blocks and the termination cabinet in the sequential order that they occur on the I/O modules and in the order that the modules occur in the I/O rack. Termination of all spares at the end of the terminal strips or arbitrarily at random positions on the terminal strips shall not be acceptable. Spare analog input points shall each have their respective internal panel circuiting completed including a powered fuse, disconnecting terminal block, three feed through terminal blocks, and a grounded terminal block for the signal shield. Refer also to Section 40 67 00.
4. I/O module usage shall comply with the following table unless noted otherwise:

	I/O Type	Module Type
a.	Analog input	4-20mA (individually isolated)
b.	Analog output	4-20mA (individually isolated)
c.	Discrete input	120VAC (individually isolated)
d.	Discrete output	120VAC (grouped with interposing relays)

5. Minimum isolation between input/output and logic voltage shall be 1500V RMS per NEMA standards via opto-isolation for AC I/O modules and 500 VDC for DC and Analog I/O modules.
6. Each I/O module shall have field replaceable fuse protection and blown fuse indicators.
7. The 24 VDC power for analog instrument loops shall be provided by the PCSI as a part of the system. The field side of the 24 VDC power sources(s) shall have individual fusing and provided with a readily visible, labeled blown fuse indicator. Grouped fusing is not acceptable.
8. Each 120VAC type discrete output shall have an associated independent interposing relay located in the same control panel. 120 VAC for relay outputs shall be provided from the control panel UPS circuit. Interposing relays shall be as specified in Section 40 67 00.
9. Where multiple mechanical components are provided for process redundancy, their field connections to I/O modules shall be arranged such that the failure of a single I/O module will not disable all mechanical components of the redundant system (i.e., inputs for Pump No. 1 on one input card, inputs for Pump No. 2 on another input card).
10. Analog Inputs: Provide analog input cards with 8-point isolated 4-20mA channels and minimum 12-bit resolution. Analog input modules shall match existing equipment.
11. Analog Outputs: Provide analog output cards with 4-point isolated 4-20mA channels and minimum 12-bit resolution. Analog output modules shall match existing equipment.
12. Discrete Inputs: Provide discrete input cards with 16-point isolated 120VAC inputs. Discrete input modules shall match existing equipment.
13. Discrete Outputs: Provide discrete input cards with 16-point (2 groups of 8) 120VAC outputs. Each discrete output shall be wired to an individual interposing relays with relay contacts wired to field interface terminal blocks. Discrete output modules shall match existing equipment.

H. PAC Rack Power Supply

1. The power supplies shall provide sufficient regulation and ripple control to assure that the rack resident devices being operated can operate within their required tolerances. Output over voltage and over current protective devices shall be provided with the power supply to protect devices from damage due to power supply failure and to protect the power supply from damage due to external failure. Transformers shall have primary and secondary fuse protection.
2. Output over voltage and over current protective devices shall be provided.
3. The PAC shall have chassis mounted power supplies to power the chassis backplane, and provide power for the processor and applicable modules. Provide power supply module selected to power the final load requirements necessary for meeting the functional requirements as specified in the Contract Documents. Provide power supply with total wattage ratings suitable for the devices and modules specified plus an additional 50% capacity.
4. PAC power supply modules shall be powered from the control panel UPS circuit.
5. Provide power supplies as manufactured by Rockwell Automation sized as required for the CPU and I/O module load requirements.
6. Refer to Section 40 67 00 for panel resident field instrument power supplies.

2.08 PAC SOFTWARE

- A. Provide a PAC configuration and application development software package complete with documentation and disks. The PAC software package shall be utilized for system configuration using the laptop computer specified herein. All software licenses and warranties shall be assigned to the Owner by the PCSI.
- B. Support on-line/off-line program development, annotation, monitoring, debugging, uploading and downloading of programs to the PACs via the Ethernet data highway.
- C. The software package shall be completely menu driven and shall be distributed on standard CD-ROM.
- D. Include a software license agreement allowing the Owner the right to use the software as required for any current or future modification, documentation, or development of the PAC's furnished for this project.
- E. The software shall be capable of the following IEC 61131-3 functions:
 - 1. Function block editor
 - 2. Sequential function chart editor
 - 3. List editor
 - 4. Structured text editor
 - 5. C programming toolkit
- F. A derived function block editor shall work with any of the above mentioned editors to create custom reusable function blocks. This software shall allow any of the derived function blocks to be modified on-line.
- G. Provide a live simulator which will allow the developer to develop and test programs without the necessity of being connected to a PAC.
- H. Programming Environment
 - 1. The CPU shall be capable of being programmed by an external IBM compatible server device via either a serial communication port on the CPU, an Ethernet communication module, or a USB communication port on an I/O bus interface. Serial programming shall be possible without the use of a workstation interface board.
 - 2. The programming device shall have access to the application program, the system configuration, all registers, I/O, system fault status, I/O override, and system diagnostic relays.
 - 3. Application programs may be loaded or stored while the CPU is running with minimal impact on the scan time.
 - 4. If contacts or entire rungs are intentionally deleted from an existing logic program, the remaining program shall be automatically repositioned to fill this void. Whenever contacts or entire rungs are intentionally inserted into an existing program, the original program shall automatically be repositioned to accommodate the expanded program.

5. The number of times a normally open (N.O.) and/or normally closed (N.C.) contact of an internal output can be programmed shall be limited only by the memory capacity to store these instructions.
6. Support multiple industry standard IEC 61131-3 programming languages. As a minimum, ladder diagram, function block diagram, instruction list, structured text and Sequential Function Chart (SFC) programming shall be provided. The Owner prefers function block diagram programming to match existing developed programming code but will accept relay ladder logic. Instruction list, SFC, or structured text programming shall not be used unless fully developed formats, data structures, layouts, and proposed program structures are submitted by the PCSI and specifically approved by the Owner. All hardware and software necessary to program the CPU in function block diagram and standard ladder shall be supplied.

I. Instruction Set

1. Perform the same functions as a conventional relay logic system, including relays, timers, counters, and high-level instructions (math, compare, memory pointers, etc.)
2. Perform all functions of conventional three-mode proportional-integral-derivative (PID) analog controllers. Each PID loop shall incorporate an anti-windup algorithm on reset.
3. Address software timers and software counters in any combination and quantity up to the limit of available memory. All management of these instructions into memory shall be handled by the CPU. Instructions shall permit programming timers in the "ON" or "OFF" delay modes. Include the capability to interrupt timing without resetting the timers. Counters shall be programmable using up-increment and down-increment.
4. When using modules such as analog where multiple channels are terminated on one module, it shall be possible to transfer the current status of all channels to the CPU upon execution of one program instruction. This instruction shall be bi-directional to include data transfer from the CPU to the module or from the module to the CPU.
5. Provide for grouping contiguous 16 bit data words into a file. The system shall address up to 1000 files with up to 1000 words per file. Support file manipulation instructions such as high speed "file copy" and "file fill", "file to file" move, "element to file" move, "file to element" move, and "first in-first out".
6. Provide asynchronous and synchronous 16 bit word shift registers. Provide synchronous bit shift registers.
7. Support a "GO TO" instruction to jump over portions of the user program to a portion marked by a matching label instruction.
8. Dynamically manage all data types to ensure consistent data types are maintained.
9. Support execution of ladder or program subroutines. It shall be possible to program several subroutines and define each subroutine by a unique program file designator. The processor will support nesting of subroutines up to seven levels deep. The program format as displayed on the CRT shall clearly define the main program and all subroutines. It shall be possible to pass selected values (parameters) to a subroutine before its execution. Subroutines shall not be nested more than one layer deep.
10. Provide "HELP" instructions which, when called by the programmer, will display a list of instructions and all data and keystrokes required to enter an instruction into the system memory.

11. Support entry of comments for all programming platforms. For example, support comment entry for ladder logic rungs, memory addresses, function or programs blocks, or within high level code. Programming platform shall allow engineering comments at the time the programming code is entered.
 12. Fault recovery support: When a major system fault occurs in the system, the fault recovery routine shall be executed and the system shall determine if the fault has been eliminated. If the fault is eliminated, program execution resumes. If the fault still exists, the system will shut down. A user shall have the option to either resume operation or to shut down upon fault detection.
 13. Provide programmable interrupt routines executed regularly over user specified intervals in the range of 1 to 65,535 milliseconds or executed based upon the input condition of one of 16 discrete hardware inputs in the processor chassis.
 14. Support indexed and indirect addressing of inputs and outputs, along with all data table words (integer, binary, floating point, timers, and counters) for the software instruction set.
 15. Supported trigonometric instructions must include Sine, Cosine, Tangent, Inverse Sine, Inverse Cosine, and Inverse Tangent. These instructions must fully support floating point math.
 16. Additional floating point instructions: Log 10, Natural Log, and Exponential.
 17. Support complex, combined calculations in a single instruction, such as flow totalizing or equations of the format $((A+((B-C)*D))/E)$.
 18. Supported file function instructions shall include Sort, Average, Square Root, and Standard Deviation.
 19. Support for ASCII string manipulation instructions such as search, concatenation, extraction, compare, and to/from integer conversion.
 20. Support ladder functions providing ASCII port control such as read, write, handshake line control, buffer examination, etc.
 21. It shall be possible to divide user logic into multiple program blocks (structured programming).
- J. The PAC programming platform shall be Microsoft Windows-based and run in a Windows 10 environment and include a 32-bit simulator. The software shall have an extensive on-line Windows-based help screens. Annotation shall be possible from any Microsoft Windows application. Full text import and export of reference data shall also be possible.
- K. The software shall include security features including preventing unauthorized personnel from modifying or downloading the program by or to unauthorized devices.
- L. PAC programming software shall be Schneider Electric, Struxeware Control Expert Pro, no equal to match existing Owner programs. Provide updates to the PAC programming software to the latest version authorized for use by the Owner at time of substantial completion per Section 40 61 00.

2.09 COMMUNICATION NETWORKS

- A. The PCSI shall furnish and install the complete IEEE 802.3 compliant Ethernet Local Area Networks (LANs) capable of supporting communications between all servers, operator workstations, PACs as shown on the system architecture block diagram. The PCSI shall furnish all necessary cables, face plates, connectors, modems, transceivers, repeaters,

modules, splice kits, etc. required for a complete and operational LAN. The system shall be designed to accommodate an increase of 100% PAC units and workstations.

- B. Alarms shall be provided on each computer to alert plant personnel of communication link cable break, stalled or malfunctioning communication director and security disconnect of malfunctioning remote systems units.
- C. Provide additional, spare network taps as part of each Ethernet network to connect a laptop computer to the networks. The taps must be easily accessible for connectivity.
- D. Industrial Managed Ethernet Switches: Where indicated on the Contract Documents, provide industry-standard ultra-wide IEEE 802.3u 100Base-TX and 100Base-FX autosensing Ethernet switches supporting Fast Ethernet communications over both fiber optic (FO) and copper cables. Provide managed Ethernet switches with 16 100Base-TX ports minimum for the MCP panel switches and 6 100Base-TX and 2 100Base-FX ports minimum for the PCP panel switches. Power supply shall be 24VDC. FO port shall be suitable for type ST connectors. Switch shall be standard DIN rail mount type for industrial application having minimum operating temperature of 60 degree C. Switch shall be Moxa, ADVANTECH, or approved equal.
- E. Ethernet 10/100BASE-T/TX Cable:
 - 1. The unshielded twisted pair cable shall be designed for use with a high speed (10/100/155/622 Mbps) Ethernet 10BASE-T, 100BASE-T/TX, and 1000BASE-T communications network. The twisted pair cable shall have a nominal impedance 100 ohms at a maximum attenuation of 32.8 dB per 100 meters at 250 MHz. The twisted pair cable shall be designed for 250MHz bandwidth operation. The twisted pair cable shall meet the ANSI/TIA-568-B.2-1 Category 6 specification. The twisted pair cable shall be plenum rated with FEP/FRPO insulation for moisture and flame protection and shall have a minimum of four 24 AWG solid copper conductor pairs. All 10/100/1000BASE-T/TX (RJ-45) terminations on the twisted pair cable shall be done in a professional and workman like manner. Terminations shall provide for proper strain relief on the cable jacket. Strain relief on the wire and/or wire insulation shall not be acceptable. Provide Ethernet cable as manufactured by Belden or approved equal.
- F. Rack Mounted Ethernet Switches
 - 1. Where indicated on the Drawings, provide industry-standard ultra-wide IEEE 802.3u 100Base-TX and 100Base-FX autosensing Ethernet switches supporting Fast Ethernet communications over both fiber optic (FO) and copper cables. Provide managed Ethernet switches with ports as required by the Drawings, plus 25% spare ports of each type.
 - 2. Power supply shall be redundant 24VDC inputs.
 - 3. FO ports shall be single-mode type with type ST connectors. Switches shall be suitable for managing a self-healing ring topology network and include STP, RSTP, and MSTP protocols for redundancy.
 - 4. Switch shall be standard 19" rack mount design having minimum operating temperature of 40 degree C,
 - 5. Switches shall be Cisco 2960, no equal, to match existing equipment.
- G. Rack Power Distribution Units (PDUs)
 - 1. Where indicated on the Drawings, provide rack PDUs capable of the following functions;

- a. Current metering on the rack PDU level. And outlet metering of current, active power, apparent power, kWh.
 - b. Environment sensor support.
 - c. TCP/IP accessibility.
 - d. Remote outlet switching.
- 2. Provide rack PDUs as manufactured by Raritan Inc, Eaton, or approved equal.
- H. Ancillary Components
- I. Serial Cable (Modbus)
 - 1. Cabling shall be 22AWG stranded tinned copper conductors with Datalene insulation, twisted pairs, overall Beldfoil shield (100% coverage) plus a tinned copper braid (65% coverage), drain wire, UV resistant PVC jacket.
 - 2. Impedance shall be greater than 100 Ohms.
 - 3. The cable shall be UL listed.
 - 4. Cable shall be as manufactured by Belden, 3105A or approved equal.
- J. Serial Splitter (Modbus RS 485 Splitter)
 - 1. Splitter shall have screw terminals for main cable and two RJ45 for tap off.
 - 2. Splitter shall have RS 485 line isolation and power shall be 24VDC.
 - 3. Splitter shall be as manufactured by Schneider Electric or approved equal.
- K. Modbus Bridge
 - 1. Modbus bridge shall be provided where indicated on the Drawings to provide data link between Ethernet TCP/IP and Modbus networks.
 - 2. Bridge shall have selector switch to select between RS-232/RS-485 communication standards.
 - 3. Device shall have status lights indicating device health and communication status. Bridge shall have four wire terminals for Modbus signal and one wire terminals for the signal ground.
 - 4. Bridge shall have two RJ45 ports. One for Ethernet connection, and another for Modbus TCP/IP connection.
 - 5. Bridge shall have minimum operating temperature of 60 degrees C. Power supply shall be 24VDC.
 - 6. Bridge shall be Modicon 174 CEV 300 10 or approved equal.

2.10 HUMAN MACHINE INTERFACE (HMI) WORKSTATIONS

- A. General
 - 1. HMI Workstation provided shall be desktop/tower type IBM compatible machine. All computer systems and related hardware shall be as specified herein or the minimum recommended and approved by the manufacturer of the Human Machine Interface (HMI) software package, whichever is greater. All workstations shall be from a single manufacturer.

2. Provide two workstations both configured as server nodes. One fully configured and tested workstation shall be installed at the PPP facility, The other fully configured and tested workstation shall be turned over to the Owner for installation at RWTP by Owner staff.

B. Hardware

1. Major hardware components of the Human Machine Interface (HMI) computer console portion of the control system shall include:
 - a. Provide HMIs with the latest version of Microsoft Windows XP Professional with latest service packs. Provide function keypads and accessories as specified herein.
 - b. CPU: Intel Core 2 Duo Processor with 45nm technology or better
 - c. Cache: 6MB L2 Minimum
 - d. Bus Speed: 1333 MHz FSB Minimum
 - e. RAM: 6 GB RAM DDR3 Dual Channel Memory and match FSB speed.
 - f. Ports:
 - 1) Integrated Audio Channel
 - 2) Two - Integrated 10/100 Mbps Ethernet (RJ45) Ports
 - 3) Integrated serial RS232C port
 - 4) Four USB 2.0 Minimum
 - g. Video Card: 512MB PCI-Express Card Minimum
 - h. Display: Samsung 22" Widescreen HD LCD Screen
 - i. 500 GB SATA Hard Drive.
 - j. Mouse: Optical Mouse
 - k. Keyboard: Standard 104-key Windows Keyboard
 - l. DVD/CD-RW drive
 - m. Power: 120VAC
 - n. Software as necessary to communicate with the PAC, and on the LAN
 - o. Minimum three years manufacturer warranty.
 - p. Manufacturer's user manuals (CDs)
 - q. Provide thin clients with the latest version of Microsoft Windows XP Professional. Thin client shall be suitable for panel mounting, or stand alone type as shown on the Drawings.

- C. Manufacturer: Dell, Hewlett-Packard, or approved equal.

2.11 LAPTOP

- A. Provide a single laptop computer for programming, testing, and troubleshooting the PACs and other equipment specified under this Contract. All laptop resident software shall be furnished and installed on the hard disk as a single user license transportable to another machine. PCSI shall provide any additional components required (including cables, software drivers, and etc) to use the laptop for remote or local PAC programming, operator

workstation, training/demonstration tool and as described above. Each laptop computer shall include as a minimum:

1. CPU: Intel Core 2 Duo Mobile Processor
2. Cache: 6 MB L2 Minimum
3. Bus Speed: 1066MHz FSB Minimum
4. RAM: 6 GB RAM DDR3 Dual Channel Memory and match FSB speed.
5. Modem: Integrated Mini-PCI 56K baud data modem
6. Pointing device: Touch Pad and Track Stick pointing device
7. One 15 pin video and S-Video out connector
8. Display: 15" Wide Screen WXGA+ or Better
9. Hard Drive: 320 GB SATA Hard Drive, partitioned to two drives (50/50)
10. Optical Drive: DVD+/-RW Drive
11. Network Interface: One 10/100 PCI Ethernet Network Interface Card
12. Wi-Fi Wireless Card: 802.16e and 802.11a/g/n wireless card
13. Media Reader: One Digital Media Reader
14. Ports: One serial, one parallel, and two USB minimum
15. Case: One carrying case
16. Battery: One spare battery
17. Operating System: Microsoft Windows XP Professional, SP3 and shall be compatible with the Owners existing operating systems.
18. Anti-Virus Software: Norton or McAfee with three years of software upgrade
19. PAC Online and Offline programming software, cables and license as specified herein
20. Documentation: Manufacturer's standard user manuals and training CDs
21. Warranty: 3 Yr Limited Manufacturer's warranty
22. FCC certification: Class B.
23. Manufacturer: Lenovo; Dell Latitude; or approved equal

2.12 HMI WORKSTATION CONFIGURATION SOFTWARE

A. General:

1. The PCSI shall match the look, feel, and standards of the existing Owner SCADA system including graphic screens, reports, database configuration, security, communication, and PAC programming to the greatest extent possible. Examples of Owner addressing approach, screen graphics, and reports will be provided to the PCSI after award of the Contract and further defined during the PCSI Coordination Workshops per Section 40 61 00. The configuration specified herein refers to general features and elements of the graphic, alarming, reporting, and other features of the SCADA system. However, all specific system elements shall conform to the Owner standards to the greatest extent possible.
2. HMI Software shall be compatible with the operating system supplied with the computers. Provide iFix 5.0 by GE/Fanuc, no equal to match existing Owner

software. Provide updates to the HMI software to the latest version authorized for use by the Owner at time of substantial completion per Section 40 61 00. Provide software and licenses for two server nodes as shown on the Contract Documents/

3. The PCSI shall provide all development software necessary to perform the work specified herein for HMI development at the PPP. All other software that may be necessary for a fully configured and operational system including communication configuration and other software shall be provided under this contract. All software licenses and warranties shall be assigned to the Owner by the PCSI.
4. Provide full server development packages and licenses for the HMIs as shown on the Drawings. The servers shall be furnished with full development packages. It shall be possible for personnel with adequate security clearance to perform all tasks except for database and graphical modifications from either platform.
5. Provide software package for data base generation; process monitoring and control; collection, analysis, storage, preparation and printing or display of operating information for historical reports; and for plant start-up, normal operating cycles, and shutdown.
6. Perform all scanning of PAC data tables for transferring analog and discrete data to and from the PAC. Scan periods shall be adjustable to ensure that the PC/PAC communications is scanning at the fastest possible time increment, without data degradation. All communications between the PACs and the operator interface software shall use the Local Area Network (LAN) directly. It is the responsibility of the PCSI to ensure direct Ethernet 802.3 communications between the PACs and the Windows XP operator interface software package provided. Communications between the operator interface and the PACs through manufacturer's proprietary data highways (serial or otherwise) or utilizing an operating system other than that specified shall not be acceptable.
7. Perform all data conversions to engineering unit and updates of data files and perform all integration signal conditioning, linearization, etc. The package shall compute data from sensor-based and/or manual inputs for mass flows, total pounds from analysis and flow, ratios, percentages, lab results, minimums, maximums, averages, medians, standard deviations, power use, etc., and store for future retrieval and/or report generation.
8. Perform standard and special calculations required for a water treatment or pumping facility including summation, totaling, averaging, geometric mean, percent removal, percent efficiency, volume, concentration, detention times, loadings, etc.
9. Perform alarm monitoring of discrete and analog inputs/outputs. The analog inputs shall also be checked for out of range (via high and low limit checks). Alarms shall be capable of being assigned to one of three severity categories with each category producing a distinct sound via the System speaker.
10. Supervise and control all routines necessary to respond to operator requests for control changes, displays, allowable operator modifications, printouts, and any other required operator requests. Operator actions shall be serviced on an interrupt basis, and shall be interwoven with normal operations.
11. Permit manual data entry through any of the terminals. Manual data shall consist of laboratory or process specific inputs and entering or changing elements such as alarm limits, setpoints, or constants. Confirmation shall be required via the respective display and keyboard prior to actual entry into the process memory. Security and password protection shall prevent unauthorized data entry.
12. Support all required graphic, semi-graphic, and alpha-numeric displays. The software will both format and display screen images of fixed and dynamic data.

13. Support all required logging and reporting. All logs, reports, and print-outs will be free form, that is the headings and format will be programmed and printed at the time of generation. Any calculations required shall be made at the time of printing. Each page of report shall have the name of the plant, type of report, time and date the report was prepared and the page number. All logs and summary reports, with the exception of the alarm and equipment status logs, shall be allowed to be manually initiated and canceled.
14. Provide the capability to manually OPEN/CLOSE, START/STOP or initiating auto sequences of selected plant equipment via the operator's screen, control device, and keyboard.
15. Provide a minimum of four levels of security to prevent unauthorized usage or modification of the system. Configure security to match existing Owner standards. Security standards shall be provided during PCSI Coordination Workshops as specified in Section 40 61 00.
16. Provide for presentation of current or historical trending values to either the screen or to the laser printer as selected by the operator.
17. Provide for an automatic reset sequence and adjustable time delay for all alarms. All alarmed analog points shall have an adjustable differential/deadband.
18. Support interface for plant equipment maintenance management and scheduling.
19. The operator interface software shall be capable of acting as a DDE server and client allowing data exchanges with other Windows applications.
20. The operator interface software shall be capable of acting as a NetDDE server when used in conjunction with Microsoft Windows products. NetDDE shall allow for sharing of data from the operator work station with other clients on a LAN.
21. Point configuration, alarm information, and communication data shall be stored in a database format that is open database connectivity (ODBC) compliant to allow management using common database tools.
22. Support up to 45,000 separate point identifiers (tags) with each tag name being up to 30 characters long.
23. Create logical expressions for use in system control using higher level language syntax or scripting.
24. Provide real-time SQL database connectivity.
25. System shall be readily expandable to accommodate future growth of up to a 100% increase in Nodes, I/O points, and HMIs.

B. Graphic Displays

1. The graphic display package shall be capable of supporting at least 256 colors. Color selection for all displays shall be configurable by the Owner. The package shall provide vector-based scalable graphic displays with a minimum pixel resolution of 1024 by 768 to conform to existing Owner displays.
2. The graphic display pages shall be able to include information from I/O points originating from various PACs, for the formation of actual and pseudo graphics. Graphic displays shall have the ability of combining dynamic analog process variables with standard symbols on the same page.
3. Provide quick switches between development and runtime operator displays.
4. Provide a library of common graphic objects and symbols suitable for ready incorporation into operator displays.

5. The graphic display package shall be capable of importing graphics from other drawing packages such as CorelDRAW and AutoCAD. The graphic display package shall be capable of importing graphics from Microsoft Windows clipboard and objects created by other Microsoft Windows applications via OLE 2.0.
6. All graphic pages shall possess the capability of "poke points" to facilitate movement of an arrow in the graphic and allow the operator to choose specific characters or images for launching linked graphic pages via a mouse.
7. Provide menu driven graphic editor with standard geometric symbols such as lines, circles, rectangles, etc. Provide graphic "wizards" and other scripting functions to simplify development.
8. Provide means to show field conditions with text that can alternate (i.e. OPEN/CLOSE, START/STOP, HIGH/LOW) and change color correspondingly. Field devices that are tri-state must be represented in three conditions. Change of conditions of field devices shall cause the corresponding graphic symbol to change or blink per Owner standards to alert the operator viewing the graphic.
9. Provide user defined menus conforming to Owner standards to select and view predetermined summaries and graphics with simple keystrokes and mouse directions.

C. Trend System

1. Supports plots of at least eight user selectable analog values in an x-y format, with each plot using a unique color. Trends shall use current or historical information with the ability to trend backward or forward from the initial time reference using a single command. Trend shall present precise numeric values for any point on the trace by moving the mouse on to the graphic trend line. The trend displays shall use shading or color change to emphasize when a particular point crosses a reference value.
2. Support transparent trends displays so that real-time and historical data can be directly compared; trend pens having different y-axis scales in engineering units; zoom functions selected by an operator selectable window; export of trend data compatible with standard spreadsheet packages; simultaneous display of historical data, data generated with standard spreadsheet packages, and SQL linked data from relational databases.

D. Database

1. Provide a menu-driven access program which allows the user to enter the database and add, delete or modify any portion of the system to configure changes, including all graphics, group, station and point records, algorithms, report generation and system functions.
2. Provide a structured package such that the HMI database can be created or edited using standard text editors or spreadsheet software packages.
3. Provide means for HMI resident data mapping function blocks for access and control of all PAC data by bit and register and implement any Owner standard function blocks used for implementing standard Owner control or monitoring functions. Any Owner standard function blocks shall be provided to the PCSI at the System Coordination Workshops as specified in Section 40 61 00.

E. Configuration

1. The system administrator shall have the capability of logging out of the current mode of operation, and with the proper password, enter the configuration mode.

2. The system administrator shall have the capability to modify group, station, and point records including all control, status, analog, pulse, auto control algorithms, limits, pseudo points, off-normal parameters and related datum pursuant to a functional field device or process.
3. The system administrator shall have the capability to modify all graphic displays including operator screen parameters such as orientation of alarm queues, graphics etc.
4. The system administrator shall have the capability to modify all report generation parameters determining logged output.
5. The system administrator shall have the capability to modify password assignment and access/control restrictions for various PAC's and related graphics.
6. The system administrator shall have the capability to modify all alarm attributes and responsibility including assigning of priorities and queues into which alarms will arrive at the operator terminals.

F. Alarm System

1. Conditions in the field designated as alarm conditions shall report to the operator terminal, actuate an audible alarm, and provide a visual blinking image on the associated graphic page.
2. The alarm condition shall be a discrete input output change of state, uncommanded change of state for discrete outputs, analog values above and below limits, high or low analog rate-of-changes as defined in the database, marginal or failed communication link and failure of a hardware device such as screens, printers, input/output module, or other major device.
3. Alarms shall be assigned priority during database configuration, based on relative importance of the alarm condition. The priority will be able to be timed, so that unacknowledged alarms can raise priority if not acknowledged within a specified time period, allowing them to appear at the top of the queue.
4. Each alarm queue shall show the highest priority alarm on the screen. The queue shall be expanded to view up to ten alarms showing the alarming devices' condition in a flashing state, the priority, the time and the alarm arrived at the polling station (hour, minute, second) and the location of the alarm. The operator will have the option of acknowledging the alarm without clearing it, deferring it for reference, or clearing it from the screen.
5. Provide alarms in tabular listings selectable chronologically or by priority, acknowledged, unacknowledged or both. No alarms may be addressed without being able to be viewed.

G. Operator Control

1. Commands related to controlling field devices or system attributes shall conform to Owner standards.

H. Print Facilities

1. Printing is not required at the site. However, support capability to operate at least one alarm/event printer and one report printer. Alarm/Event printer shall be configurable to redirect event logs to a file.
2. Printouts or logs shall include the station location name, event, date, time, priority of event if applicable, and description.

- I. Historical Data
 - 1. System shall have the capability for historical data storage stored in an OBDC compliant file formats to facilitate access to operator activity, system events, alarm messages, and point values using relational-database compatible software for data analysis, reporting and archiving. Data storage shall be implemented as specified under Part 3 herein.

2.13 UNINTERRUPTIBLE POWER SUPPLIES (UPS)

- A. Provide a UPS for the HMI workstation as specified herein.
- B. The UPS shall sustain operation of the indicated equipment and shall provide power for an orderly shutdown to prevent the loss of the System during power failure. The UPS shall provide isolation between the HMI Control System and the plant power system.
- C. The UPS shall consist of a ferroresonant transformer, a microprocessor controlled static inverter, precision 3 step battery charger, batteries to store emergency power, a detachable keypad, an electronic digital meter, and an integrally mounted manual isolated break before make bypass switch.
- D. Under normal operating conditions, the HMI workstation shall be powered by a normal AC line supply that has been filtered through the ferroresonant transformer. When AC line power is present, the inverter shall be off and the battery charger shall be off, if the batteries are fully charged. When AC line power fails, or goes out of tolerance, the inverter shall supply AC power to the transformer from the batteries. There shall be no measurable break in the output of the system during transfer from normal AC line supply to the inverter battery supply or back to line.
- E. The UPS system shall be sized to sustain 1.5 times the connected full load for a minimum period of 30 minutes in an operating environment of 32°F to 104°. Exact sizing is the responsibility of the PCSI.
- F. The UPS system shall be lightning and surge tested per ANSI/IEEE C62.41 and shall be capable of reducing an input spike to less than 3 volts on the output for a 2000 to 1 spike attenuation. The UPS system shall have 120 dB common mode and 60 dB Transverse mode noise attenuation.
- G. The UPS system shall provide a true separately derived power source as defined in the NEC article 250-5d with output neutral bonded to ground. There shall be no direct connection between input and output and less than 2 pf of effective input to output capacitance.
- H. The UPS system output shall be regulated to 120 VAC \pm 3%, 60 HZ \pm 0.5 HZ over the full dynamic range from no load to full load and low line VAC to high line VAC and low battery voltage to high battery voltage.
- I. The UPS system shall provide computer grade sine wave power with 5 percent or less total harmonic distortion.
- J. The UPS system capacity shall be rated in volt amperes (VA) while loaded with typical computer grade switch mode power supplies having a power factor of 0.6 to 0.7 and crest factor of 2.7 to 3.5.
- K. The UPS system shall have an efficiency of at least 90% when operated from AC line.

- L. The UPS system shall have built-in self-diagnostic monitoring capable of monitoring as a minimum AC volts in/out, AC current in/out, battery voltage, VA load, watts, power factor percent of full load, time of day, system hours, inverter hours and projected run time available.
- M. The UPS shall include a relay interface feature for providing isolated dry contact interface to the PAC. The interface card shall have two normally open relay contacts for remote alarm (FAIL) condition and line/utility power (FAIL) condition for reporting to the PAC.
- N. The UPS system shall have a dual track redundant configuration that utilizes either line or inverter output for power and shall be designed to meet or exceed a MTBF of 100,000 hours.
- O. All cables and connectors for power distribution to the system components shall be furnished and installed under this contract.
- P. UPS systems greater than 3 kVA shall be provided with an input voltage shall be 240 VAC, 1 phase, 60 Hertz, all others shall be provided 120 VAC, 1 phase, 60 Hertz. All others shall be provided with an input voltage of 120VAC, 1 phase 60 Hertz. The PCSI shall coordinate the input voltage and neutral requirements with the electrical contractor before ordering the UPS.
- Q. The system batteries shall be sealed, no maintenance type rated for 100 amp hour at 12 VDC.
- R. The UPS system shall be FERRUPS UPS as manufactured by Powerware or approved equal.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

- A. Refer to Section 40 61 00.

3.02 PAC COMPONENT INSTALLATION

- A. I/O Installation:
 1. Group I/O by equipment, and arrange like inputs in the same order. When there are two or more identical pieces of equipment, arrange the I/O on different I/O modules.
 2. Arrange discrete I/O as follows:
 - a. Operator mode selections (Auto, Remote, Hand, Local, etc.)
 - b. Equipment status (Ready, Running, Open, Closed, etc.)
 - c. Alarm inputs (Failure, High Temperature, Overload, Overtorque, etc.)
 - d. Other
 3. Start a set of related inputs on the 1st, 5th, 9th or 13th input, unless otherwise noted by the equipment's manufacturer.

3.03 SCADA SYSTEM CONFIGURATION

A. General:

1. The PCSI shall match the look, feel, and standards of the existing Owner SCADA system including graphic screens, reports, database configuration, security, communication, and PAC programming to the greatest extent possible. Examples of Owner addressing approach, screen graphics, and reports will be provided to the PCSI after award of the Contract and further defined during the PCSI Coordination Workshops per Section 40 61 00. The configuration specified herein refers to general features and elements of the graphic, alarming, reporting, and other features of the SCADA system. However, all specific system elements shall conform to the Owner standards to the greatest extent possible.
2. The existing Owner SCADA system central computer HMI systems at Rinconada are based on the iFIX GE/Fanuc platform. The PCSI shall provide all development software necessary to perform the work specified herein for HMI development at the PPP. All other software that may be necessary for a fully configured and operational system including communication configuration and other software shall be provided under this contract. All software licenses and warranties shall be assigned to the Owner by the PCSI.
3. Refer to Section 40 61 96 for PPP site specific control and system monitoring requirements.
4. All displays shall contain and continuously update the displayed process variables, date and time of day. All process values shall be displayed in engineering units. All displays shall incorporate references to both instrumentation tag numbers and plant equipment numbers.
5. The system shall allow the operator to control equipment such as pumps and valves as defined in the control loop drawings and control loop descriptions. All control actions shall require a two step action to assure positive verification of each control operation.
6. Unless specifically noted otherwise, all timers, setpoints, alarm actuation levels, etc., shall be adjustable from the operator interface.

B. General Displays Requirements

1. Provide graphic, alarm summary, diagnostic, trends, and other displays in conformance with Owner standards as specified herein.
2. High performance graphics shall conform to the requirements of ANSI/ISA 101.01 as required.
3. Provide graphic layouts and development conforming
4. Graphic displays: The display shall depict basic the process diagrams with representative symbols for pumps, tanks, etc., combined with real time process variables or conditions. The displays shall be dynamic (i.e., symbols for a pump shall change color indicating run or stop or alarm, the volume of tanks shall be indicated by varying the height of the interior color of the tank symbol, etc.). All of the current data in the database shall be available for graphic displays. All process variables shall be displayed on their associated display(s) with correct engineering units. Process variables shall display their associated data quality flags.
5. Alarm summary display: The display shall consist of all points currently in alarm and shall include the tag number, description, time of occurrence, and present status (high, low, normal, etc.). The alarm summary shall identify alarm points by severity by utilizing distinct colors for each severity category.
6. System diagnostic displays: The displays shall summarize the error status of all system devices capable of reporting errors (i.e., PACs, computers, network

equipment, printers, communication devices, etc.). The display shall indicate if an error is detected or a failure occurs. Status of primary and backup devices shall be indicated on display.

7. Trend displays: The trend display shall display the value of a maximum of eight assigned points versus time. Each point shall be trended in a different color. Each of the assigned points shall have a point identification number, point name, point description, current value, and instrument range displayed in the color used for its trend. The time period shall be selected and be either current or historical. The time period selected and time and date of start shall be displayed. The values displayed on a historical trend shall consist of the stored values for each variable trended. Current trends shall be updated at the scan frequency of the variable. A trend display shall not be considered a graphic display.

C. Project Specific Graphics:

1. Process graphic displays, shall be based on the P&ID's, site plan drawings, mechanical drawings and electrical drawings included in these contract documents. The graphic displays shall depict process flow streams, process structures, and all major items of process equipment and control devices in a schematic format.
2. Screen formats, colors, and layout shall match existing Owner standards for all graphical screens. General graphical requirements shall be as specified herein at a minimum.
3. The PPP shall be fully integrated into the security, trending, system alarm log, and data historian systems presently in place within the Owner SCADA system. Coordinate local logic, alarming, and historian systems with existing Owner platforms.
4. PPP Control screens for pumps, gates, flow control valves, etc. shall be configured to be fully integrated into the Owner overall central SCADA graphical system menu structure. Coordinate with Owner staff to integrate the PPP into the system control hierarchy, screen navigation, security hierarchy, failsafe logic, positive operator verification of control commands, etc.
5. Modify the system databases, alarms, and HMI/OIT graphic systems as necessary to remove all equipment demolished under this Project.
6. The PCSI shall be responsible for providing at a minimum the following graphic screens for the HMI. Final details of the graphic screen standards, formats, and development criteria shall be reviewed and finalized at the SCADA coordination workshops specified under Section 40 61 00.

- D. A graphic screen shall be defined as the process specific graphics, pump station overall performance parameters, individual pump operating parameters, etc. Secondary pop-up/pull-down screens used for control, alarm acknowledgement, etc. shall be counted as being part of an individual primary graphic screen. Screens shall comply with the control requirements as defined under Section 40 61 96.

E. Historical Data Management

1. The following features shall be provided for processing and storage of system historical data:
 - a. Develop system trending functions that incorporate data fetches from remote Owner historical archives as required for local system troubleshooting and diagnostics. Owner shall configure any off site systems for access from the PPP system. Coordinate historical data

trending capability with the Owner at the system workshops to implement full local trending capability with the Rinconada WTP data archives. Access to off-site PPP operational data shall be transparent to the user.

F. Reports:

1. System reporting shall be...

1.2 TESTING

G. Perform system testing as specified under Section 40 61 00.

END OF SECTION

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SECTION 40 67 00

CONTROL SYSTEM EQUIPMENT PANELS AND RACKS

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish and install process control panels as shown on the Drawings and specified herein.
- B. Modify existing process control panels as shown on the Drawings and as specified herein.
- C. The Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and Subcontractors to review all sections to insure a complete and coordinated project.
- D. Related Work
 - 1. Section 40 61 00 – Process Control System General Provisions
 - 2. Section 40 63 00 – Control System Equipment
- E. The following panels and consoles shall be furnished by the PCSI. Each panel shall be supplied with full sub-panels and side panels as required.

Panel Designation	Minimum Panel Size	Enclosure Rating & Type
Filter Control Panel Enclosure (FCP)	As shown on the Drawings	NEMA Type 12, 2-door, steel construction Floor Mounted Front Access Only
Filter Control Remote I/O Panel (FCP2)	As shown on the Drawings	NEMA Type 12, 1-door, steel construction Floor Mounted Front Access Only
Chemical Systems Remote I/O Panel (CECP2)	As shown on the Drawings	NEMA Type 12, 1-door, steel construction Floor Mounted Front Access Only

A

- F. The following panels and consoles shall be field modified by the PCSI. Install new components to match existing panel wiring and components.

Panel Designation	Summary of Modifications Required
Main Control Panel (MCP)	Add Profinet connection for CECP2. Replace network switch to support existing and the new fiber optic connection with FCP.

1.02 SUBMITTALS

- A. Submittals shall be made in accordance with Section 40 61 00.

1.03 QUALITY ASSURANCE

- 1. Refer to Section 40 61 00.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Control panels shall be shipped directly to the site from the factory.
- B. Throughout this Contract, the Contractor shall provide protection for materials and equipment against loss or damage and from the effects of weather. Prior to installation, store items in indoors in a dry location and follow all manufacturers' storage instructions. Provide heating in storage areas for items subject to corrosion under damp conditions. Provide covers for panels and other elements that may be exposed to dusty construction environments. Specific storage requirements shall be in accordance with the manufacturer's recommendations of the equipment being provided.

1.05 SPARES

- A. General:
 - 1. In addition to the items noted below and in the other specification sections, the Contractor shall provide suitable spare parts and expendable items in sufficient quantities to sustain the SCADA system for a period of 1 year after final acceptance. All spare parts shall be delivered to the site before testing begins.
 - 2. The following tabulation of spare parts and maintenance equipment is presented as a minimum of suitable types and quantities to be provided.
 - a. Provide the following spares:
 - 1) Fuses: 20 percent spares of each size and type used, but no less than 10 of each size and type.
 - 2) Indicating LED indicator lamps: 10 percent spares of each size and type used, but no less than two of each size and type.
 - 3) 24 VDC Power Supplies: 10 percent spares of each size and type used, but no less than two of each size and type.
 - 4) Relays: 10 percent spares of each size and type used, but no less than two of each size and type.

PART 2 - PRODUCTS

2.01 GENERAL

- A. The dimensions on the attached detail drawings are for general reference only. The PCSI shall be responsible for ensuring final enclosure sizing and panel arrangements accommodate all required equipment for a fully integrated and operational system as specified herein and in the Contract Documents.
- B. Control panels shall conform to the requirements of the NEC Article 409.
- C. Each control panel shall be manufactured and assembled per the requirements of UL 508A. The complete assembly shall bear the UL label as an Industrial Control Panel as defined by UL 508A. If required for UL labeling, provide ground fault protective devices, isolation transformers, fuses and other equipment as necessary to achieve compliance with the UL standard. The Drawings do not detail all UL requirements.
- D. The UL label requirements shall apply to all panels except where enclosures contain instruments mounted through the enclosure walls or doors. In this case, panel construction shall meet all requirements of UL labeling as described above, but no UL label is required. This exception applies only if UL Recognized instruments or devices for the intended purpose are not made.
- E. Where two or more units of the same class of materials or equipment are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.
- F. Standard products: Unless otherwise indicated, provide material and equipment that is the standard product of manufacturers regularly engaged in the production of such materials and equipment. Provide the manufacturer's latest standard design that conforms to the specifications.
- G. All panel doors shall have a lock installed in the door handle, or a hasp and staple for padlocking. Locks for all panels provided under this Contract shall be keyed alike.
- H. The instruments designated for rear-of-panel mounting shall be arranged within the panel according to respective panel drawings and in a manner to allow for ease of maintenance and adjustment.
- I. The panels shall be completely fabricated, instruments installed and wired at the PCSI's facility.
- J. The electrical schematics included in the Drawings are intended to show the basic functional requirements of the circuits depicted. Control and starter circuits shall be designed to energize to a "ready" condition such that the controlled equipment does not require a manual reset or other operator intervention to start the equipment. Provide timers and relays as necessary to perform the control, alarm, and interlock functions shown.
- K. All panel components shall be mounted in a manner that shall permit servicing, adjustment, testing and removal without disconnecting, moving, or removing any other component. Components mounted on the inside of panels shall be mounted on removable plates and not directly to the enclosure. Mounting shall be rigid and stable unless shock mounting is required otherwise by the manufacturer to protect equipment from vibration. Components mounting shall be oriented in accordance the functional requirements of the panel. Individual components shall be identified with suitable plastic or metal engraved tags

mounted adjacent to (not on) each component; tags shall identify each component in accordance with the drawing, specifications, and PCSI's data.

L. All exterior panel mounted equipment shall be installed with suitable gaskets, faceplates, etc. required to maintain the NEMA rating of the panel.

M. Nameplates

1. All panels and panel devices shall be supplied with suitable nameplates which identify the panel and individual devices as required. Each device nameplate shall include up to three lines with the first line containing the device tag number as shown on the drawings, the second line containing a functional description (e.g., Recirculation Pump No. 1), and the third line containing a functional control description (e.g., Start).
2. Unless escutcheon plates are specified or unless otherwise noted on the Drawings, nameplates shall be 3/32 inch thick, black and white, Lamicoid with engraved inscriptions. The letters shall be white against a black background unless otherwise noted. Edges of the nameplates shall be beveled and smooth. Nameplates with chipped or rough edges will not be acceptable. Nameplates shall be affixed to the panels using 4-40 thread stainless steel button head hex screws or epoxy adhesive to maintain the integrity of the NEMA panel rating.
3. Provide legend plates or 1-in by 3-in engraved nameplates with 1/4-in lettering for identification of door mounted control devices, pilot lights and meters.

N. Mounting Elevations

1. ISA Recommended Practice RP60.3 shall be used as a guide in layout and arrangement of panels and panel mounted components. Dimensions shall account for all housekeeping pads that panels will sit on once they are installed.
2. Centerline of indicators and controllers shall be located no lower than 48 inches or higher than 66 inches above the floor on a panel face.
3. Centerline of lights, selector switches and pushbuttons shall be located no lower than 32 inches or higher than 70 inches above the floor on a panel face.
4. Tops of annunciators or monitoring lights shall be located no higher than 86 inches above the floor on a panel face.
5. Installation of panel components shall conform to component manufacturers' guidelines.

2.02 TYPICAL EQUIPMENT

A. Structure and Enclosure

1. Panels shall be of continuous welded-steel construction. Provide steel angle stiffeners as required on the back of the panel face to prevent panel deflection under instrument loading or operation. Internally the panels shall be supplied with a structural steel framework for instrument support purposes and panel bracing. The internal framework shall permit panel lifting without racking or distortion. Provide removable lifting rings designed to facilitate simple, safe rigging, and lifting of the control panels during installation. Plugs shall be provided and shall unobtrusively fill the panel lifting ring holes when substituted for the lifting rings after installation is complete. Plugs shall not compromise the overall NEMA rating of the panel.

2. Each panel shall be provided with full height, fully gasketed access doors where shown. Doors shall be provided with a three-point stainless steel latch (except for NEMA 4X panels) and heavy-duty stainless-steel locking handle. Rear access doors shall be conveniently arranged and sized such that they extend no further than 24 inches beyond the panel when opened to the 90-degree position. Front and side access doors shall be as shown. Panel access doors shall be provided with full length, continuous, piano type stainless steel hinges with stainless steel pins. Front access doors with mounted instruments or control devices shall be of sufficient width to permit door opening without interference from flush mounted instruments.
3. The panels, including component parts, shall be constructed and assembled in a thoroughly workmanlike manner and shall be free from sharp edges and welding flaws. Wiring shall be free from kinks and sharp bends and shall be routed for easy access to other components for maintenance and inspection purposes.
4. The panel shall be suitable for top or bottom conduit entry as required by the Electrical Drawings. For top mounted conduit entry, the panel top shall be provided with nominal one foot square removable access plates which may be drilled to accommodate conduit and cable penetrations. All conduit and cable penetrations shall be provided with ground bushings, hubs, gasketed locknuts, or other accessories as required to maintain the NEMA rating of the panel and electrical rating of the conduit system.
5. All panels in indoor, dry, non-corrosive environments shall be NEMA 12 unless otherwise noted. All panels in outdoor, wet and non-chemically corrosive environments shall be NEMA 4 unless otherwise noted. Panels in chemically corrosive environments shall be NEMA 4X unless otherwise noted. All panels located in a Hazardous location (e.g., Class 1, Division 1) shall be rated NEMA 7.
6. Freestanding vertical panels shall meet the NEMA classification as shown on the drawings or specified herein. The panels shall be constructed of 12-gauge sheet steel, suitably braced internally for structural rigidity and strength. All NEMA 4X rated wall mounted panels shall be constructed of 316 stainless steel, unless FRP is specifically indicated to be provided. Front panels or panels containing instruments shall be not less than 10-gauge stretcher leveled sheet steel, reinforced to prevent warping or distortion.
7. Free standing panels in NEMA 4 and NEMA 4X locations shall be provided with 316 stainless steel floor stands to allow for conduit entry in the bottom of the enclosure. Conduit penetrations shall be rated for the area in which they are installed in order to maintain the NEMA rating of the panel.
8. Each enclosure shall be provided with a print pocket 12" wide x 12" high x 2" deep located on the interior of the door.
9. Where shown on the Drawings, floor mounted enclosures shall have a nominal 12" x 12" folding shelf. Folding shelf shall have steel locking support arms. Panel arrangement shall allow full opening of the folding shelf without obstructions or relocating components, panel wiring, or equipment.
10. All wall mounted panels shall meet the NEMA classification as shown on the drawings or specified herein. The panels shall be constructed of not less than USS 14-gauge steel, suitably braced internally for structural rigidity and strength. All NEMA 4X rated wall mounted panels shall be constructed of 316 stainless steel, unless FRP is specifically indicated. FRP panels shall be used in chlorine areas. All FRP panels located in direct sunlight shall be provided with a protective coating and sun shield to prevent discoloration and cracking.
11. Finish Requirements

- a. All sections shall be descaled, degreased, filled, ground and finished. The enclosure when fabricated of steel shall be finished with two rust resistant phosphate prime coats and two coats of enamel, polyurethane, or lacquer finish which shall be applied by either the hot air spray or conventional cold spray methods. Brushed anodized aluminum, stainless steel, and FRP panels will not require a paint finish.
- b. The panels shall have edges ground smooth and shall be sandblasted and then cleaned with a solvent. Surface voids shall be filled and ground smooth.
- c. Immediately after cleaning, one coat of a rust-inhibiting primer shall be applied inside and outside, followed by an exterior intermediate and top coat of a two-component type epoxy enamel. A final sanding shall be applied to the intermediate exterior coat before top coating.
- d. Apply a minimum of two (2) coats of flat white lacquer on the panel interior after priming.
- e. Unless otherwise noted, the finish exterior colors shall be ANSI 61 gray with a textured finish. Control panels installed adjacent to motor control centers or other electrical distribution equipment shall be painted to match the color of the electrical distribution equipment.

2.03 ENVIRONMENTAL CONTROL

- A. All outdoor enclosures shall be provided with a thermostatically controlled strip heater to reduce condensation and maintain the minimum internal panel temperature.
- B. All panels shall be provided with louvers, sun shields, heat sinks, forced air ventilation, or air conditioning units as required to prevent temperature buildup inside of panel. The internal temperature of all panels shall be regulated to a range of 45 Deg F to 104 Deg F under all conditions. Under no circumstances shall the panel cooling or heating equipment compromise the NEMA rating of the panel.
- C. PCSI shall submit heat dissipation calculations for every control panel.
- D. For panels mounted with their backs directly adjacent to a wall, louvers shall be on the sides.
- E. Forced air ventilation fans, where used, shall provide a positive internal pressure within the panel and shall be provided with washable or replaceable filters. Fan motors shall operate on 120-volt, 60-Hz power.
- F. For panels with internal heat that cannot be adequately dissipated with natural convection and heat sinks, or forced air ventilation, an air conditioner shall be provided.
- G. Provide custom fabricated sun shields for all outdoor panels in accordance with the following requirements:
 - 1. Sun shields shall be fabricated from minimum 12-gauge Type 316 Stainless Steel. Units shall be designed, fabricated, installed and supported to fully cover and shade the top, sides and back of the enclosure, and to partially shade the front panel of the enclosure, from direct exposure to sunlight from sunrise to sunset.
 - 2. Depending on overall size, sun shields may be fabricated in single or multiple segments for attachment to the enclosure support framing or to separate free standing framing around the enclosure.

3. Sun shields shall not be attached directly to the enclosure by drilling holes through, or welding studs to, the enclosure surfaces, and shall be designed and mounted to provide a minimum 3 inch air gap all around the enclosure for air circulation and heat dissipation.
4. The top section of all sun shields shall be sloped at a minimum angle of 5 degrees from horizontal. For wall mounted enclosures, the top section shall slope downward away from the wall and towards the front of the enclosure. For free standing, floor mounted and frame mounted enclosures the top section shall slope downward towards the back side of the enclosure.
5. The front edge of the top section of all sun shields shall incorporate a narrow and more steeply sloped drip shield segment which sheds water away from the front of the enclosure and prevents it from dripping and/or running directly onto the front panel of the enclosure.
6. All seam welds used in sun shield fabrication shall be continuous and shall be ground smooth. All exposed corners, edges and projections shall be smooth rounded or chamfered to prevent injury.

2.04 CORROSION CONTROL

- A. Panels shall be protected from internal corrosion by the use of corrosion-inhibiting vapor capsules as manufactured by Northern Technologies International Corporation, Model Zerust VC; Hoffman Model A-HCI; or approved equal.

2.05 CONTROL PANEL – INTERNAL CONSTRUCTION

A. Internal Electrical Wiring

1. All interconnecting wiring shall be stranded, type MTW, and shall have 600-volt insulation and be rated for not less than 90 degrees Celsius. Wiring for systems operating at voltages in excess of 120 VAC shall be segregated from other panel wiring either in a separate section of a multi-section panel or behind a removable Plexiglas or similar dielectric barrier. Panel layout shall be developed such that technicians shall have complete access to 120 VAC and lower voltage wiring systems without direct exposure to higher voltages.
2. Power distribution wiring on the line side of fuses or breakers shall be 12 AWG minimum. Control wiring on the secondary side of fuses shall be 14 AWG minimum. Electronic analog circuits shall utilize 16 AWG shielded, twisted pair, cable insulated for not less than 600 volts.
3. Power and low voltage DC wiring systems shall be routed in separate wireways. Crossing of different system wires shall be at right angles. Different system wires routed parallel to each other shall be separated by at least 6-inches. Different wiring systems shall terminate on separate terminal blocks. Wiring troughs shall not be filled to more than 60 percent visible fill.

B. Terminations

1. All wiring shall terminate onto single tier terminal blocks, where each terminal is uniquely and sequentially numbered. Direct wiring between field equipment and panel components, or between panel components, is not acceptable. A maximum of two wires shall be installed in a single terminal point on both the internal and field wiring side of the terminal blocks.
2. Multi-level terminal blocks or strips are not acceptable.

3. Terminal blocks shall be arranged in vertical rows and separated into groups (power, AC control, DC signal). Each group of terminal blocks shall have a minimum of 25 percent spares. Provide unique color coded terminal blocks for different voltages, functions, and signal types.
4. Terminal blocks shall be the compression type, fused, unfused, or switched as shown on the Drawings or specified elsewhere in Division 40.
5. Discrete inputs and outputs (DI and DO) shall have two terminals per point with adjacent terminal assignments. All active and spare points shall be wired to terminal blocks.
6. Analog inputs (AI) shall have five terminals per shielded pair connection with adjacent terminal assignments for each point. Terminals shall include a fused terminal block for powering loop powered devices, two terminals for connection of the analog input signal, and one terminal for DC common to be used for loop powered devices. The fifth terminal is for shielded ground connection for cable pairs. Note that additional terminals may be required for completion of a current loop of analog devices. Ground the shielded signal cable at the PAC cabinet. Provide additional fusing where required as specified under Division 40. Provide additional terminals to accommodate loops powering multiple devices such as isolators or indicators. All active and spare points shall be wired similarly with circuit wiring completed to the field terminal blocks including all protective devices, circuit tagging, and bundling specified.
7. Analog outputs (AO) shall have three terminals per shielded pair connection with adjacent terminal assignments for each point. The third terminal is for shielded ground connection for cable pairs. Note that additional terminals may be required for completion of a current loop of analog devices. Ground the shielded signal cable at the PAC cabinet. Provide additional fusing where required as specified under Division 40. Provide additional terminals to accommodate loops powering multiple devices such as isolators or indicators. All active and spare points shall be wired similarly with circuit wiring completed to the field terminal blocks including all protective devices, circuit tagging, and bundling specified.
8. Wire and tube markers shall be the sleeve type with heat impressed letters and numbers.
9. Only one side of a terminal block row shall be used for internal wiring. The field wiring side of the terminal shall not be within 4-inches of the side panel or adjacent terminal or within 8-inches of the bottom of free standing panels, or within 3-inches of stanchion mounted panels, or 3-inches of adjacent wireway.
10. Terminal blocks shall be tubular clamp type rated 600 VAC/VDC minimum and as specified on drawings. If fuse terminal blocks are specified, they shall be with built-in puller, blown fuse indicator, and with fuse size as required. Provide 20% spare terminals for every terminal strip, space permitting. Terminals shall be clearly and permanently labeled with embossed numbers as shown on drawings. Provide raised and angled terminals for incoming field device circuits.
11. Terminal block jumpers: Where indicated on the drawings, terminal block jumpers shall be pre-made specifically designed for the application. Jumpers designed to screw in on top of terminal blocks are preferred.
12. Provide all necessary accessories, partition plates, separating plates, end cover, group markers, etc., as required for proper installation of the terminal blocks.
13. Control Wiring Terminal Blocks
 - a. Standard control terminal blocks shall be designed to accept No. 22 to No. 12 AWG wires. Terminal blocks shall be color coded for functionality as

specified. Provide terminal blocks rated for 30 amperes, 600 VAC/VDC unless otherwise noted. Provide terminal blocks by the same manufacturer for all applications.

- b. Provide Single Circuit Terminal Block unless otherwise specified. Provide Allen-Bradley 1492-J4; Phoenix Contact UT 4; or equal
- c. Knife-Style Isolating Terminal Block: For analog 4-20mA or 1-5VDC applications. Provide fused terminal block/fuse insert plug with blown fuse LED indication. Provide Allen-Bradley 1492-JKD4; Phoenix Contact UDK 4-TG; or equal
- d. Fused Terminal Block: Fused terminal blocks shall be designed to accept No. 22 to No. 12 AWG copper wires. Provide blown fuse LED indication, rated for 12A, 57VAC/VDC. Provide Allen-Bradley 1492-H5; Phoenix Contact UT4 HESILED; or equal
- e. Two Circuit Terminal Block: For digital I/O field wiring interface applications only. Provide Allen-Bradley 1492-JD4; Phoenix Contact UTTB 4; or equal
- f. Grounding Terminal Block: Provide Allen-Bradley 1492-JG3; Phoenix Contact UT 2,5-PE; or equal
- g. Provide plug in jumper modules by the same manufacturer as the terminal blocks. Provide side or center jumpers with number of poles as required for the application. Provide Allen-Bradley; Phoenix Contact; or equal
- h. Provide end anchor and end barriers/covers by the same manufacturer as the terminal blocks. Provide Allen Bradley; Phoenix Contact; or equal.
- i. Provide terminal block marking systems using snap-in marker cards or pre-marked blocks. Marking system shall be the standard system from the manufacturer of the terminal blocks. Provide marking system, by Allen-Bradley; Phoenix Contact; or equal.

14. Heavy Duty Terminal Block shall be designed to accept wires up to No. 10 AWG. Terminal blocks shall be gray colored and rated for 30 amperes, 600 VAC/VDC. Acceptable products: Allen Bradley 1492 W6, Phoenix Contact Universal "UK" Terminal Blocks, or approved equal.

C. All wiring to circuits where foreign voltages are present (that is live circuits independent of the panel's normal circuit breaker protection) shall be clearly identified using yellow wiring insulation. Terminal blocks for foreign voltage circuits shall be disconnecting type. The existence of foreign circuits shall also be indicated with yellow Phenolic nameplates with on the panel exterior with red engraved lettering reading "CAUTION FOREIGN VOLTAGES PRESENT".

D. All wiring shall be clearly tagged on both ends of the wire and color coded. All tag numbers and color coding shall correspond to the panel wiring diagrams and electrical schematic drawings prepared by the PCSI. All power wiring, control wiring, grounding and DC wiring shall utilize different color insulation for each wiring system used. The color coding scheme shall be:

- 1. Incoming 120 VAC Hot – Black
- 2. 120 VAC Hot wiring downstream of panel circuit breaker – Red
- 3. 120 VAC Hot wiring derived from a UPS system – Red with Black stripe
- 4. 240, 208 or 480 VAC wiring – as specified in Division 26

5. 120 VAC neutral – White
 6. Ground – Green
 7. DC power or control wiring – Blue
 8. DC Negative – White with Blue stripe
 9. DC analog signal wiring – Black (-), White or Red (+)
 10. Foreign voltage – Yellow
- E. Power supplies and backup power:
1. Provide circuits for all internal panel power distribution including 120VAC utility power, 120VAC UPS power, and 24VDC instrument power, as shown on the Drawings and specified herein.
 2. PCSI shall be responsible for the final power supply design approach, equipment selection, equipment ratings, wiring, protective devices, and all other elements of the control panel power supplies as specified and shown on the Drawings.
 3. Provide power failure under-voltage relays or power supply alarm contacts for monitoring 24 VDC power supply and 120V AC power supply at each control panel provided under this Contract. Power failure contacts shall be wired to discrete inputs for PAC and remote I/O panels, and to terminal blocks for control panels that do not include I/O modules.
- F. Provide surge protectors on all incoming power supply lines at each panel per the requirements of Section 40 61 00. Provide control, signal and communication line surge suppression in accordance with Section 40 61 00.
- G. Each field instrument furnished under Division 40 and shown on the Drawings as deriving input power from the control panel(s) shall have a separate power distribution circuit with a circuit breaker or fuse and blown fuse indication.
- H. All internal components in the control panels shall be fed from 24 VDC power supplies as required to power field instruments, panel devices, PAC's, switches, etc. 24 VDC power supplies shall be as specified. Internal panel components and control circuits shall have a separate power distribution circuits with a circuit breaker or fuse and blown fuse indication for each powered device or for each distinct control relay circuit.
- I. Wiring trough for supporting internal wiring shall be plastic type with snap on covers. The side walls shall be open top type to permit wire changing without disconnecting. Trough shall be supported to the subpanel by stainless steel screws. Trough shall not be bonded to the panel with glue or adhesives. Provide one-inch minimum wire bending radius to prevent wires from being kinked or stressed at the wiring duct junctions. Wiring duct fills shall not exceed 50%.
- J. Each panel shall have a strip-LED light fixture for each door, mounted internally to the ceiling of the panel. The LED fixture shall be switched from a door-actuated switch that energizes when the door is opened. The LED fixture shall be fed from 120V in the control panel, unless shown otherwise on the Drawings.
- K. Each panel shall have a specification grade duplex convenience receptacle with ground fault interrupter, mounted internally within a stamped steel device box with appropriate cover. Convenience receptacle shall be powered from the panel 120V utility circuit.

- L. Each panel shall be provided with an isolated copper grounding bus for all signal and shield ground connections. Shield grounding shall be in accordance with the instrumentation manufacturer's recommendations.
- M. Each panel shall be provided with a separate copper power grounding bus (safety) in accordance with the requirements of the National Electrical Code.
- N. Additional electrical components including transformers, motor starters, switches, circuit breakers, etc. shall be in compliance with the requirements of Division 26.
- O. Relays not provided under Division 26 and required for properly completing the control function specified in Division 40, Division 26, or shown on the Drawings shall be provided under this Section.

2.06 COMPONENTS

- A. Control panels that contain motor controls, starters, drives, or circuits greater than 300VAC shall include a panel mounted molded case main circuit breaker for branch circuit overcurrent protection and disconnecting means of source power to the control panel. The panel mounted main circuit breaker shall include a NEMA-rated flange type or rotary mechanism with through door handle for operation of the main breaker. The operating mechanism shall include a mechanical interlock that will allow the panel door to open only when the handle is in the OFF position. A bypass feature shall be included such that the panel door can be opened when the handle is on the ON position.
- B. Supplementary circuit breakers may be used for isolation and protection of control cable, coils, contacts and circuit elements within the control panel and tapped from the load side of branch circuit protective devices. Use of this type of breaker is in addition to the branch circuit overcurrent breaker.
- C. A mechanical disconnect mechanism, with bypass, shall be installed on each motor circuit protector, capable of being locked in the "OFF" position to provide a means of disconnecting power to the motor.
- D. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein and as required by the detailed mechanical equipment requirements and as shown on the Drawings.
- E. Control panels that contain only low voltage control circuits shall include a DIN rail mounted UL-489 Listed main circuit breaker for branch circuit overcurrent protection and disconnecting means of source power to the control panel.
- F. All components shall be provided with finger-safe terminals. Where finger-safe terminals are not available for a specific component, the panel shall include insulated barriers to prevent accidental contact with energized components.
- G. All operating control devices and instruments shall be securely mounted on the exterior door for panels installed in interior location, inner dead-front doors for panels installed in outdoor locations, or as shown on the Drawings. All controls shall be clearly labeled to indicate function and shall be in accordance with the electrical area classification indicated on the Electrical Drawings.
- H. Indicator lamps shall be heavy duty, industrial type, high-visibility LED, push-to-test, full-voltage type pilot lights. Units shall have screw on plastic lenses and shall have factory

engraved legend plates as required. Lens colors shall be as shown on the Drawings. Indicator lamps shall be by Allen-Bradley; Eaton Corporation or approved equal.

- I. Mode selector switches (e.g. HAND-OFF-AUTO, LOCAL-OFF-REMOTE, PUMP SELECTOR, LEAD-LAG, etc) shall be heavy-duty, industrial type with contacts rated for 120 VAC at 10 Amps continuous. Units shall have standard size, black field, and legend plates with white markings, as indicated. Operators shall be black knob type. Units shall have the number of positions and contact arrangements, as required. Provide spring return style switches where shown on the Contract Documents. Units shall be single-hole mounting, accommodating panel thicknesses from 1/16-in minimum to 1/4-in maximum. Selector switches shall be by Allen-Bradley; Eaton Corporation or approved equal.
- J. Push-button, shall be heavy-duty, industrial type with momentary or maintained contacts as required, rated for 120 VAC at 10 Amps continuous. Units shall have standard size, black field, and legend plates with white markings, as indicated. Button color shall be red for EMERGENCY STOP or START and green for STOP. Contact arrangement shall be as required. Local emergency stop pushbuttons shall be red with mushroom head type, non-spring return (pull to reset type). Provide all emergency stop push-buttons with plastic finger guards to minimize risk of accidental pushbutton activation. Push-buttons shall be by Allen-Bradley; Eaton Corporation or approved equal.
- K. Indicators, selector switches, and push-buttons shall be 30mm operator devices, rated for installation in the location as shown on the Drawings.
- L. Mechanical Indicators:
 - 1. Elapsed Time Meter: Provide eight-digit, non-resettable electro-mechanical elapsed time meters. Provide 24VDC powered meters suitable for front panel mounting. Provide elapsed time meter having magnified white figures on black background, minimum 4 mm (0.16-inch) height. Meter shall be Model 8-T-65 by Eaton Corporation or approved equal.
 - 2. Start Counter: Provide six-digit, non-resettable electro-mechanical totalizer/start counters. Provide 24VDC powered meters suitable for front panel mounting. Provide counters having white figures on black background, minimum 4 mm (0.16-inch) height. Coordinate counter input pulse requirements with PAC outputs as specified in Section 40 63 00. Meter shall be Model ME Series – Durant by Eaton Corporation or approved equal.
- M. Process indicators
 - 1. Digital Process Indicators: Digital process indicators shall be 7 segment red LED displays with minimum 4-1/2 digits. Minimum digit height shall be 0.5-inches. Units shall accept current or voltage input and be housed in plastic casing suitable for front panel display of the process variable meeting NEMA 12 or better enclosure rating. Indicator shall be suitable for direct 4-20mA current loop operation, powered from 24VDC power supply. Configuration shall be via integral device keypad. Provide Red Lion Controls, Model PAXLA; Crompton; or approved equal.
 - 2. Bargraph Process Indicators: Provide combination large format process digital indicator and bargraph style panel mounted indicator.
 - a. Provide nominal 6-inch horizontal bargraph unit with minimum 30 segment red LED display on black background. Scale and span shall be configurable using device mounted pushbuttons or trim pots. Bargraph scale shall be in engineering units. Indicator shall be suitable for direct 4-20mA current loop operation, powered from 24VDC power supply. Display shall be suitable for front panel mounting meet NEMA 12 or better

enclosure rating. Provide horizontal bargraph by Ametek/Dixson, Crompton, or approved equal.

- b. Digital process indicators shall be 7 segment red LED displays with minimum 5 digits with decimal point. Minimum digit height shall be 1.5 - inches. Units shall accept current or voltage input and be housed in plastic casing suitable for front panel display of the process variable, NEMA 12 or better. Indicator shall be suitable for direct 4-20mA current loop operation, powered from 24VDC power supply. Configuration shall be via integral device keypad. Provide Red Lion Controls, Model LPAX; or approved equal.

N. Potentiometer

1. Type: Device shall be heavy duty 30mm oiltight type.
2. Functional: 270° dial; Rated for 1,000 ohms.
3. Physical:
 - a. Mounting - Suitable for panel mounting; NEMA 12 rating
 - b. Escutcheon plates scaled in engineering units or as shown on the Drawings.
4. Provide voltage to mA converter to provide a 4-20mA output signal from potentiometer for input into the PAC.
5. Manufacturers: Allen Bradley Co.; Eaton Corporation; or Square D.

O. Control Relays

1. Control relays and timers shall be 300 Volt, industrial rated, plug-in socket type, housed in a transparent polycarbonate dust cover, designed in accordance with UL Standard 508 for motor controller duty. Continuous contact rating shall be 10 Amps resistive, 1/4 Hp, at 120 VAC, with an operating temperature of minus 10 to plus 55 degrees C. Relays shall be Potter & Brumfield, KRP Series or approved equal, with calibrated timing knob.
2. Interposing relays shall be provided where external signal voltages or contact ratings are not suitable for direct interface to control panel components, or as shown on the Drawings. Interposing relays shall be DIN rail mounted, single pole type, with 6A, 120VAC rated contacts, and coils rated as required for the application. Interposing relays shall be Finder 38 Series, or approved equal.

P. Control Panel Circuit Breakers

1. Panel mounted main or branch circuit overcurrent protection breaker – Breaker shall be 120VAC, thermal magnetic type and be manufactured and tested per UL 489 standards. Short circuit rating shall be a minimum of 10kAIC. Breaker shall be suitable for panel mounting and include a through the door handle mechanism. Breaker shall be manufactured by Eaton, Square D, GE (ABB) or Equal.
2. DIN rail mounted main or branch circuit overcurrent protection breaker - Breaker shall be industrial, thermal magnetic type, 120VAC rated and be manufactured and tested per UL 489 standards. Short circuit rating shall be a minimum of 10kAIC. Breaker shall be manufactured by Eaton, Allen Bradley, Weidmuller or Equal,
3. Supplementary breakers – Supplementary breakers shall be DIN rail mounted high density, energy limiting type rated for the circuit voltage in which it is installed. Breaker shall be used per the exceptions of the NEC and as tested per UL 1077.

Breakers shall be manufactured by Eaton, Allen Bradley, GE (ABB) or approved equal.

Q. Instrument and Panel Power Supply (120VAC to 24VDC):

1. Single-phase DIN-rail mounted, switched-mode power supply with 120VAC input, 24VDC nominal output. Output shall be adjustable and regulated over the range 22.5 to 28.5 VDC. Power supplies shall be sized for their connected load plus 50% spare capacity unused for powering all the panel components provided under this Contract.
2. The power supply shall have an efficiency greater than 87% with maximum peak-to-peak voltage ripple of less than 100mV.
3. Where shown on the drawings, provide DC power supplies in a fully redundant configuration with a diode bridge redundancy module. The redundancy module shall be of the same manufacturer and series as the power supplies provided, and sized for the full capacity of each power supply. The redundancy module shall include a DC "OK" LED and an alarm contact output.
4. Power supply shall have the following status signals:
 - a. DC "OK" LED which remains lit during normal power supply operation, flashes when the output voltage has dropped by more than 10%, and is off when no input voltage is present.
 - b. An isolated DC "OK" relay contact rated 1A at 30V.
5. Acceptable products: Phoenix Contact, Sola Series, Allen Bradley, Weidmuller, or approved equal.

R. Uninterruptible Power Supply (24VDC):

1. Single-phase DIN-rail mounted, uninterruptible power supply with 24VDC input and 24VDC output. Rated for 10 amp minimum. Output shall be continuous even during a complete or partial interruption of incoming line power. UPS to include audio and visual alarms. UPS shall be UL 508 listed for installation in UL 508A Control Panels.
2. Industrial DIN rail mount uninterruptible power supply using sealed 24 VDC maintenance free hot swappable batteries. Batteries shall also be DIN rail mountable and hot swappable for ease of access and maintenance.
3. Nominal input voltage is 18VDC – 30VDC; nominal output voltage is 19.2 VDC – 27.6 VDC.
4. Rated for ambient temperatures of -13 degrees Fahrenheit up to 158 degrees Fahrenheit. At temperatures above 140 degrees Fahrenheit, derating of the power supply output occurs; power supply sizing calculations shall take this factor into account.
5. Provide USB port connection to monitor battery health, battery life, remaining battery runtime and alarms through a software interface. Provide UPS software to monitor parameters.
6. Provide service mode button on front for removal of batteries.
7. LED Status: Provide LED status lights for mains/battery mode, alarm, battery operation and bar graph for state of charge.
8. Alarms: Provide three signal outputs with two outputs configurable via the UPS software.

9. Acceptable products: Phoenix Contact QUINT UPS-DC-IQ, Weidmuller, Puls, or approved equal.
- S. Industrial Uninterruptible Power Supply (120VAC)
1. Single-phase DIN-rail or panel mounted, uninterruptible power supply with nominal 120VAC input and 120VAC output. Control panel mounted UPS systems shall be rated for 500VA with batteries sized to provide a minimum of runtime of 10 minutes at full load. Output shall be continuous even during a complete or partial interruption of incoming line power. UPS shall include audio and visual alarms for on battery, low battery, and overload. UPS shall be UL 508 listed for installation in UL 508A Control Panels.
 2. Connections shall be hard-wired to UPS terminal blocks. Furnish and install bypass relays or switches as shown on the Drawings.
 3. The UPS shall include hot-swappable internal and external battery connections to allow for battery replacement while the UPS is online, without disrupting the load circuit.
 4. Nominal input voltage is 82 VAC – 144 VAC; nominal output voltage is 120 VAC.
 5. The minimum full load efficiency shall be greater than 94%.
 6. The UPS shall be rated for operating in ambient temperatures of 0 to 40 °C
 7. LED Status: Provide LED status lights for online, on battery, overload, replace battery, and bar graphs for current load and battery state of charge.
 8. Alarms: Provide contact outputs for on battery backup and UPS fault. Contact outputs shall be rated for 30VDC and shall be wired as shown on the Drawings.
 9. Acceptable products: Schneider Electric APC model SUA500PDR-S, Allen-Bradley Bulletin 1609 series, or approved equal.
- T. Ground Bar
1. Ground bars shall be UL listed and have suitable number and size of terminals necessary for terminating stranded copper ground wires.
 2. Acceptable products: Square D Ground Bar Kits, or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install equipment specified above as shown on the drawings. Follow all manufacturers' instructions when installing panel devices and accessories.
- B. Mount circuit breakers below 79-inches.
- C. Mount common switching power supplies on horizontal or vertical DIN rail per the equipment manufacturer's recommendation so that no de-rating is required.
- D. Mount terminal blocks on vertical wireways on the bottom of the panel, unless otherwise noted by the equipment manufacturer. Field and internal terminations shall be on opposite sides of the terminal block. Arrange terminals for segregation of field and internal wires, and segregation of 120VAC wires and signal wires.

- E. Mount PAC I/O modules near the terminal block area. Arrange the modules with 120VAC I/O and signal I/O on opposite sides.
- F. Unless noted otherwise by the manufacturer's layout recommendations, layout the backpanel in the following arrangement, from top to bottom, with wireway in between each:
 - 1. Network and communications equipment.
 - 2. 24VDC power supply and DC distribution.
 - 3. 120VAC power supply and AC distribution.
 - 4. Relays and timers.
 - 5. PAC racks.
 - 6. I/O racks.
 - 7. Terminal blocks.

3.02 FIELD QUALITY CONTROL

- A. All control panel testing and documentation shall be in accordance with Section 40 61 00.

END OF SECTION

SECTION 40 70 00

INSTRUMENTATION FOR PROCESS SYSTEMS INDEX

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. The Instrument Index is included for reference only. Only major instruments are included in the Instrument Index and miscellaneous switches, relays, valves, signal conditioners, process seals, manifolds, and auxiliary devices are not included. Providing all instruments and devices necessary for a fully functioning system shall be the responsibility of the PCSI, based Section 40 61 96 – Process Control Descriptions, auxiliary device requirements, and spare requirements as shown on the Drawings and specified in these Specifications.

1.02 RELATED WORK

1. Section 40 61 00 – Process Control System General Provisions
2. Section 40 61 93 – Process Control Descriptions
3. Section 40 71 00 – Flow Measurement
4. Section 40 72 00 – Level Measurement
5. Section 40 73 00 – Pressure Measurement
6. Section 40 75 00 – Process Liquid Analytical Measurement
7. Section 40 79 00 – Miscellaneous Instruments

1.03 SUBMITTALS

- A. As specified in Section 40 61 00.
- B. The PCSI shall revise the Field Instrument Index to include the manufacturer, complete model number, and the control panel or motor control center to which the instrument is connected.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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SECTION 40 71 00
FLOW MEASUREMENT

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. This section covers the furnishing, installation, and services for the flow measurement instrumentation as shown on the Contract Documents.

1.02 RELATED WORK

- A. As specified in Section 40 61 00.
- B. Differential pressure measurement devices used to measure flow are specified in Section 40 73 00.

1.03 SUBMITTALS

- A. As specified in Section 40 61 00.

1.04 MAINTENANCE

- A. Test and maintenance equipment:
 - 1. Furnish all software applications used to configure instrumentation, and the configuration files for all instruments.
 - 2.
- B. Spares:
 - 1.
- C. Accessories
 - 1. All mounting hardware required for pipe stand, surface, or other mounting shall be provided.
 - 2. Each instrument shall be provided with a manufacturer installed stainless steel tag identifying the instrument tag number.

PART 2 - PRODUCTS

2.01 MAGNETIC FLOWMETER

- A. Flow Element
 - 1. Type:
 - a. Pulsed DC type.
 - 2. Function/Performance:
 - a. Operating Temperature: Process liquid temperatures of -10° to 70° C and an ambient of -10° to 60° C.
 - b. RFI protection: RFI protection to be provided.
 - c. Pressure rating: Equal to piping system where meter is installed.

- d. Additional: Meter shall be capable of running empty indefinitely without damage to any component.
3. Physical:
- a. Metering Tube: 304 stainless steel or equivalent.
 - b. Flanges: ANSI 150 lb. or DIN PN 16 carbon steel, as required by the piping system, unless otherwise indicated.
 - c. Liner: Polyurethane unless otherwise indicated on the Drawings or in the Instrument Device Schedule.
 - d. Electrodes: 316 stainless steel, bullet nosed or elliptical self-cleaning type unless otherwise noted.
 - e. Housing: Meters below grade shall be suitable for submergence for up to 48 hours to a depth of 30 ft (9m). Meters above grade shall be NEMA 4X (IP65). Where hazardous areas are indicated on the Drawings, the equipment shall be rated for that area.
 - f. Finish: All external surfaces shall have a chemical and corrosion resistant finish.
4. Accessories/Documentation Required:
- a. Factory calibration: All meters shall be factory calibrated. A copy of the report shall be included in the O&M manual and ORT documentation.
 - b. Grounding: Meter shall be grounded in accordance with the manufacturer's recommendation. Provide ground ring, ground wires, gaskets, etc., as required. All materials shall be suitable for the liquid being measured.
 - c. Electrode cleaning unit: Where indicated in the Instrument Device Schedule, provide an electrode cleaning system. The system generator/controller shall be housed in a NEMA 4X wall mounted enclosure. Provide all necessary cables and connectors. The generator shall be powered through manufacturer supplied cables for the magnetic flowmeter or from the A/C supply to the transmitter.
 - d. Signal cable for installation between the flowtube and the transmitter. Length shall be as required by installation indicated on the Drawings.
5. Manufacturer(s):
- a. Rosemount (Emerson) Series 8700.
 - b. Endress Hauser Promag 51W.
 - c. Krohne OPTIFLUX 2000.
 - d. Siemens SITRANS F M MAGFLO.
 - e. ABB Instruments MagMaster.
 - f. McCrometer UltraMag.
- B. Flow Converter/Transmitter
1. Type:
- a. Microprocessor based, intelligent transmitter compatible with flowtube provided.

- b. The transmitter shall be mounted integrally on the flow tube, or remotely mounted on an instrument stand, wall, or control panel as shown on the Drawings.
2. Functional/Performance:
- a. Accuracy (including flowtube): Plus/minus 0.5 percent of flowrate.
 - b. Operating Temperature: -10 to 50° C.
 - c. Output: Isolated 4-20 mA with HART protocol. Current output adjustable over the full range of the instrument.
 - d. Diagnostics: Self diagnostics with on screen display of faults.
 - e. Display: Digital indicator displaying flow in engineering units indicated in the Instrument Device Schedule.
 - f. Totalizer: A fully configurable totalizer integral to the transmitter. Totalized flow shall be displayed.
 - g. Empty Tube Zero: The transmitter shall include a feature that will lock the output at zero when no flow is detected. The empty tube zero feature shall be enabled automatically when the transmitter detects no flow or manually through a contact input.
3. Physical:
- a. Transmitter shall be suitable for surface or instrument stand mounting.
 - b. Enclosure shall be NEMA 4X (IP65).
 - c. 120VAC input power or as shown on the Instrument List.
4. Accessories/ Required:
- a. Keypad where required for transmitter configuration.
 - b. If hand-held programmers, special tools, software or cables are required for configuration and setup, the contractor shall provide one set of configuration equipment, plus an additional set of configuration equipment for every five flow meters provided on this project..
5. Manufacturer(s):
- a. Rosemount Series 8712.
 - b. Endress Hauser Promag 51 Series.
 - c. Krohne IFC 100.
 - d. Siemens SITRANS Magflow Series 5000.
 - e. ABB Instruments MagMaster Transmitter.
 - f. McCrometer ProComm.

2.02 VENTURI FLOW TUBES

- A. Type:
- 1. Pressure differential producing type utilizing pure static pressure sensed at the inlet and throat sections. Flow tubes with devices which employ entire or partial pitot effects, or which amplify the differential, are not acceptable.

- B. Function/Performance:
1. Coefficient of Discharge: Greater than 0.98 and constant for pipe Reynolds numbers as low as 75,000.
 2. Pressure: Each flow tube shall withstand hydrostatic pressure equal to that specified for the piping system in which the flow tube is to be installed.
 3. Accuracy: Plus or minus 0.5 percent of the specified flow rate.
 4. Differential Pressure: The beta ratio of the venturi flowtube shall be selected to minimize unrecovered head loss, while providing a pressure differential of at least 1 inch (25 mm) of water column at the minimum specified flowrate.
 5. Unrecovered Head Loss: Unless indicated on the drawings, supply of venturi flowtubes having one of the standard beta ratios provided by the manufacturer will be acceptable, provided the unrecovered head loss is less than 10 percent of differential pressure.
 6. It shall be the responsibility of the PCSI to verify all pipe sizes and coordinate with the Contractor before ordering any flow elements.
- C. Provide differential pressure transducer for flow monitoring as specified in Section 40 73 00.
- D. Physical:
1. Body Material: Cast iron to ASTM A126 Class B or equivalent standard, finished with bitumastic paint.
 2. Throat Liner: Stainless steel.
 3. Flanges: ANSI Class 125 or DN flanges as required by the piping system where flow tubes are installed.
- E. Construction: Internal cross sections shall be circular with no debris collecting cavities or annular chambers, but shall have static pressure connections at the inlet and throat. Vent and drain ports shall be included on a 90 degree plane to the metering tap on the inlet section.
- F. Accessories/Documentation Required:
1. Provide manual vent cleaners where indicated in the Instrument Device Schedule.
 2. The flow tube shall be factory calibrated. The calibration data shall be included in the O & M manual.
 3. Prior to shipment of the flow tube, the supplier shall submit a certified report that the flow tube has been hydrostatically tested to 1.5 times the maximum working pressure of the pipeline where the flow tube is installed.
 4. The supplier shall provide certified documentation from the as to the head loss in inches of water. The supplier shall also provide test data substantiating the value of the discharge coefficient with proof that the coefficient is independent of line size and beta ratio; test data indicating Reynolds number effect and installation effect data for the model of the venturi flow tube proposed. All test data shall be provided from traceable national standards laboratories.
 5. The contractor shall provide straightening vanes where indicated on the Drawings or in the Instrument Device. The vanes shall be of material suitable for the measured fluid and compatible with the piping system provided.
 6. Provide an inspection port on all tubes 12-in (300 mm) and larger.

7. Where the flow tube is indicated to be used on potable water service, the interior cast iron surfaces shall be epoxy coated with Tnemec No. 46-272 Topox or an approved equal coating fully acceptable for potable water service.

8. One set of gaskets suitable for the installation indicated on the Drawings.

G. Manufacturer(s):

1. Primary Flow Signal HVT-CI.
2. Badger.
3. Approved equal.

2.03 EMERGENCY EYEWASH/SHOWER FLOW SWITCH

A. Type:

1. Eyewash/shower actuated flow switch.

B. Function/Performance:

1. Output: SPDT, 20VA, 120 VAC.

C. Physical:

1. Switches for pipe sizes of 1 to 1-1/2 inches, as shown on the Drawings.
2. Flow body and all wetted parts shall be 316 stainless steel.
3. Switch housing shall be NEMA 4X (IP65).

D. Manufacturer(s):

1. Gems Sensors FS200 Series
2. Dwyer Flotect
3. Guardian
4. Approved equal.

PART 3 - EXECUTION

3.01 GENERAL

A. Install in conformance with manufacturer's requirements and as specified under Section 40 61 00.

3.02 TRANSIT TIME FLOWMETER INSTALLATION

A. Provide services of a mechanical or welding pipeline specialist for installing the permanently mounted ultrasonic transducers internally to the main pipe system. Installation shall conform to the requirements of sensor material, final sensor placement, pipe inner lining material, and external pipe material.

B. Provide a factory trained field service technician for initial inspections. Service technician shall provide installation assistance to the Contractor, monitor final installation, and coordinate the sensor crystal impedance for the specific application, sensor installation

location (external or internal to pipe), and pipe materials and linings. Field services shall also include and testing the sensors and transmitters after installation (dry test), calibration, and commissioning. The flowmeter systems shall each be tested under flow conditions with field service reports including diagnostics starting, signal strength and sound speed. All reports shall be submitted to the Engineer.

- C. Provide factory trained field service technician for providing training to District staff. Training of staff shall occur within four weeks of the internally mounted flowmeter installation. A second training sequence shall occur within four weeks of the first pump flowmeter installation. Each training sequence shall include two separate four-hour sessions (four sessions total) and scheduled to conform to District staff shift operations. Training shall include basic system operations, diagnostics, maintenance, and troubleshooting utilizing the manufacturer's standard operation and maintenance literature. Pump flowmeter training shall specifically address sensor removal and reinstallation as required for future pump system maintenance or equipment removal. Training sessions shall all be held at the PPP with schedules coordinated with District staff. Provide minimum six week advance notification of training schedules. All training sessions may be video taped by the District.
- D. Strap-on Ultrasonic Transducer Installation
 - 1. Installation of transducers and transmitters shall be field coordinated and verified with District staff to ensure that device installations shall not preclude future sensor removal for maintenance of pump, piping, or other ancillary systems systems.
 - 2. The steel pipe for flowmeter sensor installation is mortar lined. Thickness of mortar is unknown and may require that the manufacturer provide measuring equipment for determining the thickness of the mortar and pipe material. Coordinate installation with cement lining conditions.
- E. Internally Mounted Ultrasonic Flowmeter
 - 1. Installation of the permanently mounted transducers within the main line requires that the facility shut down and the line dewatered. This work effort shall be coordinated with the scheduling and constraint requirements of the Contract Documents.
 - 2. All District and other applicable regulatory requirements regarding entering and working in the main pipe confined space shall be followed per the Special Provisions.
 - 3. The manufacture shall provide a factory trained field service technician to provide services for locating the clamp-in transducers inside the pipe and providing final installation points and calibration. Access to the interior of the pipe shall conform to the District's confined space requirements and all applicable State and Federal requirements as specified in the Special Provisions.
 - 4. The 24" discharge steel pipe is mortar lined. Thickness of mortar is unknown and shall require that the Contractor determine the thickness of the mortar and pipe material and incorporate into the mounting scheme submittal as specified herein.
 - 5. Mounting and attachment to the mortar lined pipes shall be performed by a licensed pipeline Contractor. All materials for attaching the transducer shall be provided.
 - 6. Provide Schedule 80 PVC conduit for routing signal cables from transducer to transition junction box and fittings as shown on the Drawings. Provide all couplings and conduit fittings for attaching the transducer fitting to the conduit system. Final sealing of the penetrations, conduits, seal fittings, drain fittings and other components shall be as determined by the Contractor and following the approved installation submittal as specified herein.

7. Conduits shall be permanently mounted to inside of pipe to provide support and withstand the pressure and turbulence of the water.
 8. If wiring to new transducers/new electrical devices in pipe manifold is shielded, shield wire shall not be connected to pipe to prevent loss of existing cathodic protection.
- F. Testing of the flow meter system shall be included to confirm signals are received properly at the transmitter prior to transmission to the plant SCADA system. Verify that signals are in conformance with the manufacture's recommendations and to verify proper system operation.

END OF SECTION

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SECTION 40 72 00
LEVEL MEASUREMENT

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. This section covers the furnishing, installation, and services for the level measurement instrumentation as shown on the Contract Documents.

1.02 RELATED WORK

- A. As specified in Section 40 61 00.

1.03 MAINTENANCE

- A. Test and maintenance equipment:
 - 1. Furnish all software applications used to configure instrumentation, and the configuration files for all instruments.
 - 2. .
- B. Spares:
 - 1.
- C. Accessories
 - 1. All mounting hardware required for pipe stand, surface, or other mounting shall be provided.
 - 2. Each instrument shall be provided with a manufacturer installed stainless steel tag identifying the instrument tag number.

PART 2 - PRODUCTS

2.01 ULTRASONIC LEVEL / DIFFERENTIAL LEVEL METER

- A. Transducer
 - 1. Type:
 - a. Non-contact, ultrasonic level transducer.
 - 2. Function/Performance:
 - a. Measuring Ranger: Transducer range shall be suitable for the installation indicated on the Drawings, up to 50 ft (15m).
 - b. Temperature Range: -30 to 70° C.
 - c. Relative humidity: 0 to 100 percent.

- d. Temperature Compensation: Transducers shall be provided with integral temperature sensors for temperature compensation.
3. Physical:
- a. Transducers shall be potted/encapsulated in a Kynar or other chemical and corrosion resistant housing. Where indicated on the Drawings, transducers shall be approved for installation in Class I, Division 1, Groups C and D (Zone 0) environments.
 - b. The surface of transducers shall be Teflon coated where mounted on chemical tanks and exposed to vapors in the tanks that are not compatible with the transducer material.
 - c. Transducers shall be capable of being completely submersed without damage.
 - d. Transducers shall be suitable for surface, pipe, or flange mounting as indicated on the Drawings or Instrument Device Schedule. Appropriate mounting hardware shall be provided. Flanges shall be nominal 8-inch or as shown on the Drawings, resistant to attack by the medium being metered, or where required, shall be protected by corrosion resistant coatings and facings.
4. Options/Accessories Required:
- a. Transducers located in areas where freezing condensation may occur shall be provided with special heaters or other type of transducer protection designed to prevent sensor icing.
 - b. Signal cable as recommended by the manufacturer, for installation between the transducer(s) and the transmitter. Length, up to 1000 feet (300 m), shall be as required by installation indicated on the Drawings.
5. Manufacturer(s):
- a. Siemens Model XPS
 - b. Endress+Hauser FDU92
 - c. Approved equal.
- B. Transmitter/Converter
- 1. Type:
 - a. Microprocessor based compatible with the transducer(s) provided.
 - 2. Functional/Performance:
 - a. Resolution (including transducer): Plus/minus 0.1% of range or 0.08 inches (2 mm), whichever is greater.
 - b. Accuracy (including transducer): Plus/minus 0.25% of range or 0.24 inches (6 mm).
 - c. Range: As required by the installation indicated on the drawings.
 - d. Temperature Range: -20 to 50° C.
 - e. Output: One isolated 4-20 mA output with HART communication and 4 alarm contacts adjustable to trip at any point in the instrument range. Output contacts shall be rated 5 A at 230 VAC.
 - f. Temperature Compensation: Compensation over the temperature range of the sensor.

- g. Display: Digital indicator displaying level/differential level or volume in engineering units or percent as indicated on the Drawings or in the Instrument Device Schedule.
 - h. Diagnostics: On screen instructions and display of self-diagnostics.
 - i. Loss of Signal: Transmitter shall ignore momentary loss-of-echo signals and shall indicate loss of echo on the transmitter unit.
 - j. Configuration Protection: Programmable parameters shall be protected using E2PROM. Battery backup protection is not acceptable
3. Physical:
- a. Transmitter shall be suitable for surface or pipe stand mounting.
 - b. Enclosure shall be NEMA 4X (IP65).
 - c. 120VAC input power or as shown on the Instrument List.
4. Accessories Required:
- a. Handheld programmer where required for configuration and calibration of the instrument.
5. Manufacturer(s):
- a. Siemens Model HydroRanger 200
 - b. Endress+Hauser FMU95
 - c. Approved equal.

2.02 RADAR LEVEL METER

- A. Type:
- 1. Non-contact, microwave type level meter.
- B. Function/Performance:
- 1. Measuring Range: Range as indicated in the Instrument Device Schedule, up to 50 ft (15m).
 - 2. Accuracy: Plus/minus 0.3 percent or plus/minus 1.2 inches (30mm) whichever is greater.
 - 3. Operating Temperature: -40° to 60° C.
 - 4. Output: Isolated 4-20 mA output with HART communication.
 - 5. Display: Digital indicator displaying level or volume in engineering units or percent, as indicated on the Drawings or in the Instrument Device Schedule.
 - 6. Diagnostics: On screen instructions and display of self-diagnostics.
- C. Physical:
- 1. Instrument shall be provided with a stainless steel 3 inch Class 150 lb. (DN 80, PN16) mounting flange.
 - 2. Housing shall be NEMA 4X (IP66). Where the instrument is installed in a hazardous area, the housing shall be explosion proof approved for Class I, Division 1, Groups C and D (EEx d IIB T4) installation. The instrument shall be certified for installation of the antenna in a Class I, Division 1, Groups C and D (Zone 0) environment.

3. Transducer cone type, size, and beam frequency shall be as recommended by the manufacturer for the specific application in which it is to be installed.
 - a. Two-wire: 24 VDC loop powered from instrument power supply as specified under Section 40 67 00. [4-Wire: powered from 120VAC]
- D. Accessories Required:
 1. Where required for calibration/programming, a hand held programmer shall be provided.
- E. Manufacturer(s):
 1. Vega VegaPuls 64
 2. Siemens LR 200
 3. Rosemount 5400
 4. Approved Equal

2.03 FLOAT SWITCH - FIXED MOUNT

- A. Type:
 1. Ball float switch.
- B. Function/Performance:
 1. Differential: Less than 6 inches (125 mm).
 2. Output: Switch rated 2 A at 120 VAC.
- C. Physical:
 1. Float: Polypropylene or similar material.
 2. Switch: Hermetically sealed mechanical switch housed in a chemical-resistant polypropylene casing. No mercury allowed.
 3. Cable: Heavy duty, PVC jacketed, integral to float. Sufficient cable length shall be provide so that no splice is required in the wet well, reservoir, or process vessel.
- D. Manufacturer(s):
 1. Anchor Scientific Eco-Float
 2. Flygt (Xylem)
 3. Magnetrol T10
 4. Approved equal.

PART 3 - EXECUTION

3.01 GENERAL

- A. Install in conformance with manufacturer's requirements and as specified under Section 40 61 00.

END OF SECTION

SECTION 40 73 00

PRESSURE MEASUREMENT

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. This section covers the furnishing, installation, and services for the pressure measurement instrumentation as shown on the Contract Documents.

1.02 RELATED WORK

- 1. Refer to Section 40 61 00.
- B. Differential pressure-based flow elements (FE) are specified under Section 40 71 00.

1.03 MAINTENANCE

- 1. Refer to Section 40 61 00
- B. Test equipment:
 - 1. Furnish all software applications used to configure instrumentation, and the configuration files for all instruments.
 - 2.
- C. Spares:
 - 1. .
 - 2.
- D. Accessories
 - 1. All mounting hardware required for pipe stand, surface, or other mounting shall be provided.
 - 2. Each instrument shall be provided with a manufacturer installed stainless steel tag identifying the instrument tag number.
 - 3. Pressure instruments shall be provided with isolation valves, bleed valves, valve manifolds, tubing, pipe manifolds, process seals, and fittings as shown on the Drawings.

PART 2 - PRODUCTS

2.01 DIFFERENTIAL PRESSURE TRANSMITTERS

- A. Type:
 - 1. Microprocessor based, intelligent type.

B. Function/Performance:

1. Range: Range of the transmitter shall be the standard range of the manufacturer closest to the differential pressure range to be metered.
2. Accuracy: 0.05 percent of span (linear output).
3. Operating Temperature: -20 to 80° C.
4. Temperature Effect: Combined temperature effects shall be less than 0.2 percent of maximum span per 28° C temperature change.
5. Static Pressure Effect: Effect on accuracy due to static pressure changes shall be negligible.
6. Output: 4-20 mA DC adjustable over the instrument range, with HART protocol.
7. Output shall be linear for differential pressure applications. For flow metering applications the output shall be proportional to the square root of the input differential pressure.
8. Stability: 0.2 percent of upper range limit for 5 year.
9. Display: Digital indicator displaying differential pressure or flow in the engineering units indicated in the Instrument Device Schedule.
10. Diagnostics: Self diagnostics with transmitter failure driving output to above or below out of range limits.
11. Over Range Protection: Provide positive over range protection to 150% of the maximum pressure of the system being monitored by the instrument.

C. Physical:

1. Enclosure: NEMA 4X (IP66), explosion proof, approved for Class I, Division 1, Groups C and D (EEx d IIC T5).
2. Process Wetted Parts: Isolating diaphragm and other wetted metal parts shall be 316L stainless steel, unless otherwise indicated in the device schedule. Gaskets and O rings shall be Teflon.
3. Instrument flange shall include a 316 stainless steel drain/vents for each process connection.
4. Power Supply: 24 VDC loop power.
5. Sensor Fill Fluid: Silicone.

D. Accessories Required:

1. Provide span and zero adjustment at each transmitter and through the handheld programming unit.
2. For each transmitter provide five valve manifold. The manifold shall be 316 stainless steel. Manifolds may be mounted directly to the instrument or separately mounted. Manifolds shall be by the instrument manufacturer, D/A Manufacturing, or Anderson Greenwood.
3. Provide mounting accessories necessary.

E. Manufacturer(s):

1. Rosemount 3051CD.
2. Endress+Hauser PMD75.

3. ABB 621ED.
4. Foxboro by Schneider Electric IDP10
5. Approved equal.

2.02 GAUGE PRESSURE OR PRESSURE SENSING LEVEL TRANSMITTERS

A. Type:

1. Microprocessor based, intelligent type.

B. Function/Performance:

1. Range: Range of the transmitter shall be the standard range of the manufacturer closest to the pressure range to be metered.
2. Accuracy: 0.05 percent of span.
3. Operating Temperature: -20 to 80° C.
4. Temperature Effect: Combined temperature effects shall be less than 0.2 percent of maximum span per 28° C temperature change.
5. Output: 4-20 mA DC linear with pressure or level, with HART protocol.
6. Zero adjustable over the range of the instrument provided calibrated span is greater than the minimum calibrated span.
7. Stability: 0.2 percent of upper range limit for 1 year.
8. Display: Digital indicator displaying pressure or level in the engineering units indicated in the Instrument Device Schedule.
9. Diagnostics: Self diagnostics with transmitter failure driving output to above or below out of range limits.
10. Over Range Protection: Provide positive over range protection to 150% of the maximum pressure of the system being monitored by the instrument.
11. If required to meet the range or suppression/elevation requirements, a differential pressure transmitter shall be provided.

C. Physical:

1. Enclosure: NEMA 4X (IP66), explosion proof, approved for Class I, Division 1, Groups C and D (EEx d IIC T5).
2. Process Wetted Parts: Isolating diaphragm and other wetted metal parts shall be 316L stainless steel, unless otherwise indicated in the device schedule. Gaskets and O rings shall be Teflon.
3. Power Supply: 24 VDC loop power.
4. Sensor Fill Fluid: Silicone.

D. Accessories Required:

1. Provide span and zero adjustment at each transmitter and through the handheld programming unit.
2. For each transmitter provide a 316 stainless steel block and bleed valve. Valves may be mounted directly to the instrument or separately mounted. Valves shall be by the instrument manufacturer or by D/A Manufacturing or Anderson Greenwood.

- E. Manufacturer(s):
1. Rosemount 3051CG
 2. Endress+Hauser PMC71.
 3. ABB 621EG.
 4. Foxboro by Schneider Electric IGP20
 5. Approved equal.

2.03 FLANGE MOUNTED PRESSURE SENSING LEVEL TRANSMITTER

- A. Type:
1. Flanged mounted, microprocessor based, intelligent type.
- B. Function/Performance:
1. Range: Range of the transmitter shall be the standard range of the manufacturer closest to the pressure range to be metered.
 2. Accuracy: 0.075 percent of span.
 3. Operating Temperature: -20 to 80° C.
 4. Temperature Effect: Combined temperature effects shall be less than 0.2 percent of maximum span per 28° C temperature change.
 5. Output: 4-20 mA DC linear with pressure or level with HART protocol.
 6. Zero adjustable over the range of the instrument provided calibrated span is greater than the minimum calibrated span
 7. Stability: 0.2 percent of upper range limit for 1 year.
 8. Display: Digital indicator displaying level in the engineering units indicated in the Instrument Device Schedule.
 9. Diagnostics: Self diagnostics with transmitter failure driving output to above or below out of range limits.
 10. Over Range Protection: Provide positive over range protection to 150% of the maximum pressure of the system being monitored by the instrument.
- C. Physical:
1. Enclosure: NEMA 4X (IP66), explosion proof, approved for Class I, Division 1, Groups C and D (Exx d IIC T5).
 2. Process Wetted Parts: Isolating diaphragm and other wetted metal parts shall be 316L stainless steel, unless otherwise indicated in the device schedule. Gaskets and O rings shall be Teflon.
 3. Flange: Flange shall be ANSI 3 inch, 150 lb. (DN 80, PN 25 or 40). Flange shall be minimum 316 stainless steel or as shown in the Instrument Device Schedule.
 4. Power supply shall be 24 VDC loop power.
 5. Sensor Fill Fluid: Silicone.
- D. Accessories Required:
1. Provide span and zero adjustment at each transmitter and through the handheld programming unit.

2. Provide seals for the flange connection suitable to the process liquid being metered.
- E. Manufacturer(s):
1. Rosemount 3051L
 2. Endress+Hauser FMD77.
 3. ABB 621ES.
 4. Foxboro by Schneider Electric IDP10.
 5. Approved equal.

2.04 PRESSURE SWITCH

- A. Type:
1. Diaphragm actuated.
- B. Function/Performance:
1. Repeatability: Better than 1 percent of full scale.
 2. Setpoint: Field adjustable and set between 30 and 70 percent of the adjustable range.
 3. Dead Band: Fixed unless adjustable dead band requirement is noted in the Instrument Device Schedule.
 4. Reset: Unit shall be of the automatic reset type unless noted otherwise in the Instrument Device Schedule.
 5. Over Range Protection: Over range protection to 150% of the maximum process line pressure.
 6. Output: Single pole double throw (SPDT) unless requirement for double pole double throw (DPDT) switch is shown on the instrument device schedule. Switch rating shall be 10 A at 230 VAC.
- C. Physical:
1. Housing: NEMA 4X (IP65) for non hazardous areas. For installation in hazardous areas, housing shall be explosion proof approved for Class 1, Division 1, Groups C and D (EEx d IIB).
 2. Switch Assemblies: Hermetically sealed switches.
 3. Wetted Parts: 316L stainless steel diaphragm, viton seals, 316 stainless steel connection port.
- D. Accessories/Options Required:
1. Shutoff Valve: Provide a 316 stainless steel shutoff valve. Valve shall be by D/A Manufacturing, Anderson Greenwood, or approved equal.
 2. Where indicate on the instrument device schedule, provide a 316 SS snubber for pulsation dampening.
- E. Manufacturer(s):
1. Static-O-Ring (SOR)

2. Ashcroft
3. Mercoïd by Dwyer
4. Approved equal

2.05 DIFFERENTIAL PRESSURE SWITCH

A. Type:

1. Diaphragm actuated.

B. Function/Performance:

1. Setpoint: Field adjustable and set between 30 and 70 percent of the adjustable range.
2. Dead Band: Fixed deadband.
3. Over Range Protection: Over range protection to twice the maximum process line pressure.
4. Output: Dry contacts rated 10 A at 230 VAC. Single pole double throw (SPDT) unless requirement for double pole double throw (DPDT) switches is shown on the instrument device schedule.

C. Physical:

1. Housing: NEMA 4X (IP65) for non hazardous areas. For installation in hazardous areas, housing shall be explosion proof approved for Class 1, Division 1, Groups C and D (EEx d IIB T5).
2. Switching Assemblies: Hermetically sealed switches.
3. Wetted Parts: 316L stainless steel diaphragm, viton seals, 316 stainless steel connection port.

D. Accessories/Options Required:

1. For each differential pressure switch, provide a three valve manifold. The manifold shall be 316 stainless steel. Manifolds shall be D/A Manufacturing or Anderson Greenwood.

E. Manufacturer(s):

1. Static-O-Ring (SOR)
2. Ashcroft
3. Mercoïd by Dwyer
4. Approved equal.

2.06 PRESSURE GAUGE

A. Type:

1. Dry type process gauge.

- B. Function/Performance:
1. Range: Range of the gauge shall be the standard range of the manufacturer closest to the pressure range to be measured.
 2. Accuracy: 0.5 percent of span.
 3. Operating Temperature: -20 to 90° C.
 4. Output: 4-20 mA DC linear with pressure or level, with HART protocol.
 5. Display: Mechanical dial indicator displaying pressure in the engineering units indicated in the Instrument Index.
- C. Physical:
1. Size: 4-1/2" Dial size
 2. Enclosure: Phenolic case, NEMA Type 4X.
 3. Process Wetted Parts: Isolating diaphragm and other wetted metal parts shall be 316L stainless steel, unless otherwise indicated in the device schedule. Gaskets and O rings shall be Teflon.
 4. Sensor Fill Fluid: Silicone.
- D. Accessories Required:
1. Provide diaphragm seals where shown on the P&ID drawings.
 2. For each gauge provide an isolation valve to isolate the gauge assembly from the process fluid.
- E. Manufacturer(s):
1. Ashcroft 1279 Series
 2. Ametek-US Gauge
 3. Or equal.

2.07 PROCESS INSTRUMENT SEALS

- A. Provide diaphragm seals and annular seals where shown on the Drawings or where the instrument wetted parts are not chemically compatible with the process fluid being measured. Provide isolation valve between seal and process to allow isolation and replacement of the seal and instrument.
- B. Provide separate diaphragm seals for each instrument, gage, switch, etc. in a manifold assembly.
- C. Provide low range diaphragm seals in applications having setpoints less than 30 psi. Low range diaphragms shall include additional mounting support hardware if pipe size or material does not have suitable strength or rigidity to properly support the seal assembly.

- D. Provide seals with integral 1/8-inch NPA flushing connection.
- E. Diaphragm Seal - Threaded
 - 1. Type:
 - a. Thread attached.
 - b. Welded Metal Diaphragm.
 - 2. Function/Performance:
 - a. Maximum Pressure: Two times the maximum process pressure.
 - b. Operating Temperature: -40 to 100° C.
 - 3. Physical:
 - a. All 316L stainless steel construction.
 - b. Teflon gaskets and O rings on process connection.
 - c. Filling screw and bleeding connection provided.
 - 4. Accessories Required:
 - a. Stainless steel armored capillary tubing as required for the installation.
 - 5. Manufacturer(s):
 - a. Ashcroft
 - b. Rosemount
 - c. Eaton
 - d. Approved equal
- F. Annular Seal
 - 1. Type:
 - a. Line mounted, between two flanges.
 - 2. Function/Performance:
 - a. Pressure Limit: Correspond to flange ratings.
 - b. Inside diameter shall conform to the dimensions of the pipe where the seal is installed.
 - c. ANSI or DIN flange class shall be equivalent to the flange class of the piping where the seal is installed. Bolting dimensions shall conform to ANSI or DIN drilling specifications as required by the installation.
 - 3. Physical:
 - a. Body material: Carbon steel.
 - b. Process connection: 1/4-inch NPT.
 - c. Sensing Sleeve: Buna-N.
 - d. Sensing Liquid: Silicone Oil.
 - 4. Manufacturer(s):
 - a. Red Valve Company, Inc.
 - b. Wika

- c. Approved equal

PART 3 - EXECUTION

3.01 GENERAL

- A. Install in conformance with manufacturer's requirements and as specified under Section 40 61 00.

END OF SECTION

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SECTION 40 75 00

PROCESS LIQUID ANALYTICAL MEASUREMENT

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. This section covers the furnishing, installation, and services for the process analyzer instrumentation as shown on the Contract Documents.

1.02 RELATED WORK

- 1. As specified in Section 40 61 00 – Process Control System General Provisions.

1.03 MAINTENANCE

- A. Test equipment:
 - 1.
- B. Spares:
 - 1.
- C. Accessories
 - 1. All mounting hardware required for pipe stand, surface, or other mounting shall be provided.
 - 2. Each instrument shall be provided with a manufacturer installed stainless steel tag identifying the instrument tag number.

PART 2 - PRODUCTS

2.01 LOW RANGE TURBIDITY ANALYZER

- A. Type:
 - 1. Micro processor based, continuously flowing, 90 degree light scatter type turbidimeter capable of transmitting turbidity data on a network.
- B. Function/Performance:
 - 1. Accuracy: Plus/minus 2% of reading from 0 to 10 NTU, plus/minus 5 % of reading from 10 to 40 to NTU, and plus/minus 10% of reading from 10 to 100 NTU.
 - 2. Repeatability: Plus/minus 1% of reading or plus/minus 0.002 NTU, whichever is greater.
 - 3. Resolution: 0.0001 NTU up to 9.9999 NTU, and 0.001 NTU from 10.000 to 99.999 NTU.
 - 4. Range: 0.001 to 100 NTU.

5. Environmental Conditions: 0 to 40 °C and 5 to 95 percent relative humidity, non-condensing.
 6. Output: Two 4-20 mA outputs adjustable over the full instrument range, and at least 2 SPDT alarm contacts rate 5A at 230 VAC, which can be adjusted to trip at any point in the instrument range.
 7. Display: Digital indicator displaying turbidity in NTUs.
- C. Physical:
1. Suitable for wall or floor stand mounting.
 2. Where required, a DC power supply shall be provided with each turbidimeter. A/C power will be as specified in Section 40 61 00.
 3. NEMA 4X (IP66) enclosures.
- D. Accessories Required:
1. A factory calibrated optical device for verification of calibration without the use of consumables.
 2. One year supply of consumables for calibration.
 3. All cables, connectors, and tubing required for a fully operational turbidimeter.
- E. Manufacturer(s):
1. Hach Model 1720E.
 2. Approved equal.

2.02 HIGH RANGE TURBIDIMETER

- A. Type:
1. Microprocessor based nephelometer, 90 degree light scatter type turbidimeter capable of transmitting turbidity data on a network.
- B. Function/Performance:
1. Accuracy: Plus/minus 5 percent of reading or 0.1 NTU from 0 to 2000 NTU, whichever is greater, and plus/minus 10% NTU from 2000 to 9999 NTU.
 2. Repeatability: Plus/minus 1 percent.
 3. Resolution: 0.01 NTU below 100 NTU, and 0.1 NTU from 100 to 9999.9 NTU..
 4. Range: 0 to 9999 NTU.
 5. Operating Temperature: 0 to 50 °C.
 6. Output: One 4-20 mA output adjustable over the full instrument range, and at least 2 SPDT alarm contacts rate 6A at 230 VAC, which can be adjusted to trip at any point in the instrument range.
 7. Diagnostics: On screen display of self-diagnostics.
 8. Display: Digital indicator displaying turbidity in NTUs.
- C. Physical:
1. Suitable for wall or bench mounting.

2. A/C power will be as specified in Section 40 61 00.
3. Turbidimeter control units shall have corrosion resistant enclosures certified NEMA 4X. Sample unit enclosures shall be NEMA 12.
4. Digital indicator displaying NTUs.

D. Accessories Required:

1. Bubble trap and head regulator to vent entrained air bubbles from the sample and maintain regulated sample flow.
2. Spare lamp for turbidimeter with incandescent light sources.
3. All cables and connectors required for a fully operational turbidimeter.
4. One year supply of consumables for calibration.
5. Standardization plates or optical cube for verification of calibration without use of consumables.

E. Manufacturer(s):

1. Hach Surface Scatter 7.
2. Approved equal.

2.03 CHLORINE RESIDUAL ANALYZER **[AMPEROMETRIC TYPE]**

A. Type:

1. Microprocessor based electronic transmitter/converter with a flow through sample cell.
2. Measures free or total chlorine. Analyzer to be configured for free or total chlorine as indicated on the Drawings or the Instrument Device Schedule.
3. Utilizes amperometric methods.

B. Function/Performance:

1. Range: 0-10 ppm for either free or total Chlorine.
2. Environmental Conditions: The instrument shall operate over an ambient temperature range of 5-45 °C.
3. Output: Isolated 4-20 mA output and 3 alarm contacts rated 5 A at 230 VAC, adjustable to trip at any point in the instrument range.
4. Display: Dot matrix or LCD type displaying chlorine residual in ppm.
5. Temperature Compensation: Compensated for sample temperatures over the temperature range of the instrument.
6. Diagnostics: On screen instructions and self diagnostics.
7. Total Chlorine:
 - a. Low Limit Of Detection (LOD): 0.03 ppm or better.
 - b. Repeatability/precision: 0.03 ppm or 3%, whichever is greater.
 - c. Response time: 90% of full scale within 100 seconds.
8. Free Chlorine:
 - a. Low Limit Of Detection (LOD): 0.03 ppm or better.

- b. Repeatability/precision: 0.03 ppm 3%, whichever is greater.
- c. Response time: 90% of full scale within 140 seconds.

C. Physical:

- 1. Analyzers shall be suitable for surface mounting.
- 2. A/C power will be as specified in Section 40 61 00.
- 3. Electronics enclosure shall be NEMA 4X.
- 4. Sensor shall have three electrodes and shall have an automatic cleaning mechanism.

D. Accessories Required:

- 1. Provide one year supply of consumables and one spare electrode.

E. Manufacturer(s):

- 1. Hach CLx10sc
- 2. Capital Controls Series CL1000.
- 3. Approved equal.

2.04 CHLORINE RESIDUAL ANALYZER [COLORIMETRIC TYPE]

A. Type:

- 1. Microprocessor based electronic transmitter/converter with a flow through sample cell.
- 2. Measures free or total chlorine. Analyzer to be configured for free or total chlorine as indicated on the Drawings or the Instrument Device Schedule.
- 3. Utilizes colorimetric chemistry.

B. Function/Performance:

- 1. Range: 0-5 ppm for either free or total Chlorine.
- 2. Environmental Conditions: The instrument shall operate over an ambient temperature range of 0-40 °C.
- 3. Accuracy: plus/minus 5 percent of reading, or plus/minus 0.03 ppm, whichever is greater.
- 4. Resolution: 0.01 ppm.
- 5. Output: Isolated 4-20 mA output and 3 alarm contacts rated 5 A at 230 VAC, adjustable to trip at any point in the instrument range.
- 6. Display: Dot matrix or LCD type displaying chlorine residual in ppm.
- 7. Temperature Compensation: Compensated for sample temperatures over the temperature range of the instrument.
- 8. Diagnostics: On screen instructions and self diagnostics.
- 9. Minimum detection limit: 0.03 ppm.
- 10. Repeatability: 0.05 ppm.

C. Physical:

1. Analyzers shall be suitable for wall mounting.
2. A/C power will be as specified in Section 40 61 00.
3. Enclosure shall be NEMA 12, IP-62 rated.

D. Accessories Required:

1. Provide one year supply of reagent.

E. Manufacturer(s):

1. Hach CL17
2. Approved equal.

2.05 TURBIDITY AND SUSPENDED SOLIDS ANALYZER

A. Type:

1. Turbidity and suspended solids sensor shall utilize a dual-beam infrared/ scattered light photometer.
2. LED light source shall transmit light at 45 degrees to the sensor face.

B. Functional/Performance:

1. Response Time: T90 in less than 1 second.
2. Temperature Range: 0 to 40 °C.
3. Sensor Life:
4. Accuracy:
 - a. Turbidity: Less than 1% of reading or plus/minus 0.001, whichever is greater
 - b. Suspended solids: Less than 5% of reading
5. Repeatability:
 - a. Turbidity: Less than 1% of reading
 - b. Suspended solids; Less than 3% of reading
6. Measurement Range:
 - a. Turbidity: 0.001 to 4000 NTU
 - b. Suspended solids: 0.001 mg/l to 50 g/l (inline), or 0.001 mg/l to 500 g/l (highline)
7. **Output:**
8. Digital display indicating the turbidity or suspended solids, alarm or fault messages, and diagnostic information.

C. Physical:

1. Suitable for immersion in a tank or insertion into a pipe, or as indicated on the Drawings.
2. **NEMA rating**
3. Sensor shall have a self-cleaning wiper.

4. A DC power supply shall be provided with each transmitter. The power supply shall be installed in an enclosure having the same certification as the enclosure for the transmitter. A/C power will be provided at the voltage and frequency stated in Section 40 61 00.

D. Accessories Required:

1. Mounting brackets for mounting as indicated on the drawings.
2. In non-hazardous areas, remote sensor enclosures shall be NEMA 4X (IP65). Where indicated in the Instrument Device Schedule or on the Drawings to be installed in hazardous areas, enclosures shall be explosion proof, approved for Class 1, Division 1, Groups C and D (EEx d IIC T4) areas.
3. A sampling module shall be provided with the assembly when a sample is needed to be drawn up from an enclosed tank to the sensor. The module shall be suitable for Class I, Division I, Group D classifications and meet NEMA 4X requirements.

E. Manufacturers:

1. Hach SOLITAX, sc
2. Approved equal

2.06 COMMON CONTROLLER

A. Type:

1. Microprocessor-based sensor controller with single or dual channels, compatible with digital and analog sensor modules.
2. Controller accepts 4 different analog sensor modules in any combination to measure: pH/Dissolved Oxygen, conductivity, flow, analog ma IN.

B. Functional/Performance:

1. Relative humidity: 0 to 95%, non-condensing
2. Digital display with LED backlight indicating alarm or fault messages, and diagnostic information.
3. Output: Two isolated 4-20 mA programmable outputs, and at least 4 SPDT alarm contacts rated 5A at 220 VAC.
4. pH/ORP sensor module
 - a. Measurement range:
 - 1) -2.0 to 14.0 pH or -2.00 to 14 pH
 - 2) -2.100 to 2.100 mV
 - b. Repeatability: plus/minus 1% of range
 - c. Response time: T90 in less than 0.5 seconds
 - d. Temperature range:
 - 1) PT100/PT1000: -20 to 200 °C
 - 2) NTC300: -20 to 110 °C
 - 3) Manual: -25 to to 400 °C

5. DO sensor module
 - a. Measurement range:
 - 1) 0 to 40 ppm
 - 2) 200% saturation
 - b. Repeatability: plus/minus 0.05% of range
 - c. Response time: T90 in less than 0.5 seconds
 - d. Temperature range: 0 to 50 °C
6. Contacting conductivity sensor module
 - a. Measurement range:
 - 1) Conductivity: 0 to 2,000, 0 to 20,00, 0 to 200.0 or 0 to 2,000 $\mu\text{S}/\text{cm}$
 - 2) Resistivity: 0 to 19.99 $\text{M}\Omega\cdot\text{cm}$ or 0 to 999.9 $\text{k}\Omega\cdot\text{cm}$
 - 3) TDS: 0 to 9999 ppm
 - b. Repeatability:
 - 1) 0 to 20 $\mu\text{S}/\text{cm}$, K=1: 0.02 mS/cm
 - 2) 20 to 200,000 $\mu\text{S}/\text{cm}$, K=1: plus/minus 1% of reading
 - c. Response time: T90 is less than 0.5 s
 - d. Temperature range: -20 to 200 °C
7. Inductive conductivity sensor module
 - a. Measurement range:
 - 1) Conductivity: 0 to 200.0 or 0 to 2,000 $\mu\text{S}/\text{cm}$
 - 2) % concentration: 0-99.99 or 0-200.0%
 - 3) TDS: 0 to 9999 ppm
 - b. Repeatability:
 - 1) > 500 $\mu\text{S}/\text{cm}$: plus/minus 0.5 % of reading
 - 2) \leq 500 $\mu\text{S}/\text{cm}$: plus/minus 2.5 $\mu\text{S}/\text{cm}$
 - c. Response time: T90 in less than 1 second
 - d. Temperature range: -2 to 200 °C
8. Ultrasonic flow sensor module
 - a. Measurement range:
 - 1) Flow rate: 0 to 9999, 0 to 999.9, or 0 to 99.99 with selectable flow rate units (gal., ft^3 , acre-ft., liter, m^3)
 - 2) Volume: 0 to 9,999,999 with selectable volume units
 - 3) Depth: 0 to 1200.0 in., 0 to 100.0 ft., 0 to 30,000 nm or 0 to 30.00 m
 - b. Repeatability: plus/minus 0.1% of span
9. Paddle wheel flow sensor module
 - a. Measurement range:

- 1) Flow rate: 0 to 9999, 0 to 999.9, or 0 to 99.99 with selectable flow rate units (gal., ft.³, acre-ft., liter, m³)
- 2) Volume: 0 to 9,999,999 with selectable volume units

C. Physical:

1. Suitable for rail, panel, pipe, and surface mounting.
2. Enclosure shall be NEMA 4X, rated IP66
3. A DC power supply shall be provided with each transmitter. The power supply shall be installed in an enclosure having the same certification as the enclosure for the transmitter. A/C power will be provided at the voltage and frequency stated in Section 40 61 00.

D. Accessories Required:

1. Mounting brackets for mounting as indicated on the drawings.
2. In non-hazardous areas, remote sensor enclosures shall be NEMA 4X (IP65). Where indicated in the Instrument Device Schedule or on the Drawings to be installed in hazardous areas, enclosures shall be explosion proof, approved for Class 1, Division 1, Groups C and D (EEx d IIC T4) areas.

E. Manufacturers:

1. Hach sc200
2. Approved equal

PART 3 - EXECUTION

3.01 GENERAL

- A. Install in conformance with manufacturer's requirements and as specified under Section 40 61 00.

END OF SECTION

SECTION 40 80 00

COMMISSIONING OF PROCESS CONTROL SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. A single Process Control System Integrator (PCSI) shall furnish all services and equipment for the Owner, Plant facility controls, local communication networks, local interfaces to remote communication networks, and project field instrumentation as specified herein.
- B. The Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and Subcontractors to review all sections to ensure a complete and coordinated project.

1.02 SCOPE OF WORK

- A. The PCSI work shall include the following:
 - 1. Provide all
- B. Related Work
 - 1. Section 40 61 00 – Process Control System General Provisions

1.03 SUBMITTALS

- A. General
 - 1. Coordinate testing and training submittals with the requirements of Section 40 61 00
- B. Submittal Requirements: Separate submittals shall be made for:
 - 1. Testing Plan
 - 2. Training Plan
- C. Testing Plan
 - 1. Test Procedure Submittals: Submit the procedures proposed to be followed for each test. Procedures shall include test descriptions, forms, and checklists to be used to control and document the required tests. Include sign-off forms for each testing phase or loop (per the Specifications) with sign-off areas for the PCSI, the Owner, and the Engineer. Refer to Part 3 of this Section for testing requirements. Submit separate procedures for each specified test phases including:
 - a. Unwitnessed Factory Test (UFT)
 - b. Witnessed Factory Test (WFT)
 - c. Operational Readiness Test (ORT)
 - d. Functional Acceptance Test (FAT)
 - e. 30-Day Acceptance Test.

2. Test Documentation: Upon completion of each required test, document the test by submitting a copy of the signed off test procedures. Testing shall not be considered complete until the signed-off test procedures have been submitted and favorably reviewed. Submittal of other test documentation, including “highlighted” I/O electrical schematic wiring diagrams with field technician notes are not acceptable substitutes for the formal test documentation.

D. Training Plan

1. Training Plan Submittal: Upon receipt of Engineer's comments on the preliminary training plan included in the Project Plan, submit a final training plan. Training method and coverage shall be in conformance with the system training as specified herein. The training plan shall include:
 - a. Definitions of each course.
 - b. Specific course attendance.
 - c. Schedule of training courses including dates, duration and locations of each class.
 - d. Resumes of the instructors who will actually implement the plan.

1.04 TESTING AND COMMISSIONING WORKSHOPS

- A. The PCSI shall schedule and hold a mandatory testing and commissioning control system Coordination Workshop. The workshop shall include as a minimum the Owner, the Engineer, the Contractor, the PCSI's Project engineer, and electrical subcontractor. Owner staff shall include construction managers, technicians, operators, and maintenance staff as required. The Owner shall determine which staff members will attend each workshop. Workshops shall all be held at the Owner's Plant located at 300 Olympia Dr. Pittsburg, CA, 94565.
- B. Schedule the Commissioning Workshops a minimum of two weeks prior to the workshop date and include a draft agenda at the time of the request for review. Within one week subsequent to each workshop, submit draft workshop minutes for review and comment; submit final minutes incorporating any comments as necessary. The PCSI shall be responsible for facilitating the workshop and providing presentation material to all participants. The PCSI and Contractor shall document the proceedings of the Coordination Workshops and submit along with all materials used at the workshop.
- C. Workshop
 1. Project On-Site Testing, Training, Startup & Commissioning Workshop: Following successful completion of the PCSI Factory Testing but prior to startup of the main control panel and first set of pump control panels, PCSI shall conduct a four (4) hour workshop. The intent of this workshop is for the PCSI and Contractor to provide a review of the project schedule and project execution regarding testing, startup, and training as follows:
 - a. On Site Testing: Summarize the schedule for each stage of field testing and identify the teams that will be responsible for the testing. The PCSI and Contractor shall prepare a summary of how all the testing will be performed, documented, and submitted. Draft test forms as specified herein shall be presented at the workshop.
 - b. Training: The PCSI and Contractor shall provide a listing of all the scheduled training that will take place with anticipated dates in accordance with these Specifications. The PCSI and Contractor shall also prepare a

summary of personnel and qualifications of the individuals responsible for the training. Also indicate the target audience for the training. Any off-site training should be coordinated with the Owner staff at least 30 days prior to training.

- c. Startup: The PCSI and Contractor shall coordinate startup and integrate into the startup plan, the Owner modifications at Rinconada. The PCSI and Contractor shall provide the draft startup plan including schedule for the startup and the personnel responsible for the startup. The plan shall be reviewed by and coordinated with the Owner operations, technical, and engineering staff to accommodate Owner operational requirements. The PCSI and Contractor shall be responsible for the preparation of all documentation that will be used for the startup testing and verification as specified herein.
 - d. Commissioning: Contractor shall review the Commissioning plan and provide status of required deliverables including but not limited to:
 - 1) O & M's
 - 2) Spare Parts
 - 3) Warranties
 - 4) Service Agreements
 - 5) Special equipment and tools
2. As required workshops: One ***[add workshops as required]*** additional workshop shall be included for this project over and above the workshop defined above. The topics and scheduling of this additional workshop shall be solely at the discretion of the Owner to address additional project requirements that may arise during construction. Attendance at the additional workshop shall include at a minimum the Contractor, electrical subcontractor, PCSI, and Owner representatives. Duration of the workshop shall be determined by the topic and discussion points but assume the additional workshop shall be 4 hours in length. Specific personnel required for the workshops shall be determined based on the workshop topics to be addressed. Owner shall provide a minimum of 2 weeks' notice to the PCSI of the need for the workshop after which the PCSI shall prepare a workshop agenda, coordinate workshop schedule, and facilitate the workshop.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 TESTING

A. General

1. As part of the requirement of this Specification Section it is the responsibility of the PCSI to provide a complete operational control system. Confirmation of an operational control system is dependent upon results derived from test procedures as specified in this Section.
2. Perform factory testing prior to shipment of the equipment and testing of the equipment once installed in the field. Once the system is in operation an additional 30-Day Acceptance Test is required.

3. Each test shall be in the cause-and-effect format. The person conducting the test shall initiate an input (cause) and upon the system's or subsystem's producing the correct result (effect), the specific test requirement will have been satisfied.
4. All tests shall be conducted in accordance with prior Engineer approved procedures, forms, and checklist all as submitted by the PCSI under Part 1 of this Specification. Each test to be performed shall be described and a space provided after it for signoff by the appropriate parties after its satisfactory completion. Include "punch list" forms with the test procedure to document issues that arise during the testing. Punch list forms shall include a resolution section that allows a description of the correction and signoff areas for PCSI and Engineer.
5. Copies of the sign-off test procedures, forms and checklists will constitute the required test documentation. The test result forms shall be submitted to the Engineer for approval at the completion of each test.
6. Provide all special testing materials and equipment. Wherever possible, perform tests using actual process variables, equipment, and data. Where it is not practical to test with real process variables, equipment, and data, provide suitable means of simulation. Define these simulations techniques in the test procedures.
7. The PCSI shall coordinate all required testing with the Contractor, all affected Subcontractors, packaged system suppliers, the Engineer, and the Owner.
8. The PCSI shall furnish the services of field service engineers, all special calibration and test equipment and labor to perform the field tests.
9. The Engineer reserves the right to test or retest all specified functions, whether or not explicitly stated on the Test Procedures, as required to determine compliance with the functional requirements of the overall system. Such testing required to determine compliance with the Specified requirements shall be performed at no additional cost to Owner. The Engineer's decision shall be final regarding the acceptability and completeness of all testing.
10. No equipment shall be shipped until the Owner and Engineer have received all test results and approved the system is ready for shipment.

B. Testing Sequence

1. General: Control system testing sequence shall be coordinated with the construction commissioning sequence and the Special Provisions.
2. Factory Testing shall be performed at the PCSI fabrication shop facility or at a local facility provided under this Contract within 120 miles of the Owner's headquarters whichever is closer. Contractor shall refer to the Special Provisions for travel expense information and coverage.
3. Factory Testing shall be performed with all system control panels, HMIs, network equipment, and communication media in place and functional. All system programming shall be completed for PAC control logic, HMI graphics, network addressing (conforming to Owner addressing requirements) so that the Factory Tests are completed and verifying that all system components and elements are operating properly and as specified prior to being shipped to the site.
4. Upon successful completion of the Factory Tests, the PCSI shall coordinate shipping or storage of the system elements as required by the Contractor and as specified to coordinate delivery with the construction schedule.
5. Operational Readiness Test (ORT) and Functional Acceptance Test (FAT) shall be performed after installation of the process control system. Testing shall be scheduled and coordinated with Owner staff as specified herein. Testing shall include 100% verification of all new data points to and from the HMI system.

6. The 30-day Acceptance Test shall be conducted after completion of the FAT for all systems and processes.
- C. Factory Testing: Prior to shipment of the equipment the following tests are required:
1. Unwitnessed Factory Test (UFT).
 - a. The entire system except for primary elements, final control elements, and field mounted transmitters shall be interconnected and tested to ensure the system will operate as specified. All analog and discrete input/output points not interconnected at this time shall be simulated to ensure proper operation of all alarms, monitoring devices/functions and control devices/functions.
 - b. All panels, consoles and assemblies shall be inspected and tested to verify that they are in conformance with related submittals, Specifications and Drawings. During the tests all digital system hardware and software shall be operated for at least five days continuously without a failure to verify the system is capable of continuous operation.
 - c. Tests to be performed shall include but not be limited to the following. Each of these tests shall be specifically addressed in the Test Procedure submittal.
 - 1) 100% wiring and database address verification of panel components and process controller I/O as applicable.
 - 2) Demonstrate functionality of the process controls in conformance with the process control loop descriptions. Simulate operating conditions to verify the performance of the monitoring and control functions.
 - 3) Demonstrate graphical user interfaces (hardware and software) for process controllers and HMI.
 - 4) Demonstrate the data communication networks and protocols for transmission and receipt of data on all network connected devices.
 - 5) Demonstrate all system software functions specified including system heartbeats, clock synchronization, and data export to other application platforms.
 - 6) Generate reports using test data.
 - 7) Test system recovery from failure scenarios including cold boot, warm boot, communication loss, power failure, process failure, redundancy backup systems, etc.
 - 8) Other tests as necessary to verify the complete functionality of the entire control system.
 - d. Submit summary results of UFT including certified statement of successful completion of all UFT tasks.
 2. Witnessed Factory Test (WFT)
 - a. Repeat the same series of tests as for the UFT but in the presence of the Owner and the Engineer. All elements of the WFT shall be witnessed by the Owner and the Engineer. Provide two weeks schedule notification to the Owner and the Engineer prior to performing the WFT. The WFT shall not be held until after favorable review of all hardware, software, and test

procedure submittals as specified herein and successful completion of the UFT.

b. Submit WFT results for review by Engineer.

D. Field Testing - Following installation of the process control system components and conforming to the testing sequence described above perform the following:

1. Operational Readiness Test (ORT)

a. General: Prior to startup and the Functional Acceptance Test, the indicated system elements shall be certified (inspected, wired, calibrated, tested, and documented) that it is installed and ready for the ORT as defined below.

b. Loop/Component Inspections and Tests: System shall be checked for proper installation, calibrated and adjusted on a loop-by-loop and component-by-component basis to ensure that it is in conformance with related submittals and these Specifications. Preliminary PID loop tuning shall be completed as specified herein. Related loops shall be tested as a system to verify interlocks, operations of functionally related loops, etc. all as specified in Section 40 61 96.

c. The Loop/Component Inspections and Tests shall be implemented using PCSI developed, Engineer-approved forms and checklists. Each loop of functionally related group of loops (subsystem) shall have a Loop/Subsystem Status Report to organize and track inspection, adjustment and calibration. These reports shall include the following information and checkoff items with spaces for sign off by the system supplier:

- 1) Project Name, Test Date, PCSI Name, and Lead PCSI Technician Name
- 2) Loop Number or Loops Numbers of a Tested Subsystem
- 3) Tag Number for each component.
- 4) Checkoffs/signoffs for each component:
 - a) Tag/identification (Loop or Subsystem name)
 - b) Installation
 - c) Termination – wiring and tubing
 - d) Scale, Range, and Setpoint as applicable
 - e) Calibration/adjustment (4 point for analog, set point for switches) rising and falling
- 5) Checkoffs/signoffs for the loop
 - a) Panel interface terminations
 - b) I/O interface terminations
 - c) I/O signal operation
 - d) Inputs/outputs operational: received/sent, processed, adjusted
 - e) Total loop operation and operation of subsystem associated loops per Section 40 61 96.

- 6) Space for comments
 - d. The PCSI shall maintain the Loop Status Reports sheets at the job site and make them available to the Engineer at any time.
 - e. These inspections, calibrations, and tests do not require witnessing. However, Engineer shall review Loop Status Sheets and spot-check the PCSI test process periodically. Any deficiencies found shall be corrected by the PCSI prior to commencement of the Functional Acceptance Test.
 - f. Submit ORT results for review by Engineer.
2. Functional Acceptance Test (FAT).
- a. General: Prior to startup, the installed instrument and control system elements as described above shall be certified that it is ready for operation. A witnessed FAT shall be performed on the system to demonstrate that it is operating and in compliance with these Specifications. All preliminary testing, inspection, and calibration shall be complete as defined in the Operational Readiness Test.
 - b. Each specified function and process control shall be demonstrated on a paragraph-by-paragraph, loop-by-loop, panel-by-panel, and site-by-site basis. FAT shall be correlated to the functional verification of the process control descriptions of Section 40 61 96 addressing specific elements of overall system and sub-system control.
 - c. PCSI shall perform network testing for each network segment including equipment provided in other sections of the Contract Document. Test and coordinate operation of the network including all network connected components, as shown on the Drawings. Testing shall include performance and error tracking using standard network administration software. Testing shall confirm that network performance meets or exceeds the system and network performance criteria developed by the PCSI and as specified herein.
 - d. Loop-specific and non-loop-specific tests shall be the same as specified under Factory Tests except that the system shall be tested, and all functions demonstrated using live field-based data to the greatest extent possible. In addition, related loops shall be tested as a system to verify interlocks, operations of functionally related loops, etc. all as specified in Section 406196.
 - e. Updated versions of the documentation specified to be provided for during the Factory Tests shall be made available to Engineer at the job site during the tests. In addition, one copy of all O & M Manuals shall be available for reference at the job site during testing.
 - f. Following initial startup, the SCADA control system shall operate for a continuous 100 hours without failure before this test will be started. Network testing and performance testing shall be on-line and monitoring network operation throughout the 100-hour period.
 - g. Punchlist items and resolutions noted during the test shall be documented on the Punchlist/Resolution form. In the event of rejection of any part or function test procedure, the PCSI shall perform repairs, replacement, and/or retest within 10 days.
 - h. Submit FAT results for review by the Engineer.

3. 30-Day Acceptance Test

- a. After completion of the Operational Readiness and Functional Acceptance Tests, the PCSI shall be responsible for operation of the system for a period of 30 consecutive days, without a single non-field repairable malfunction. The 30-day acceptance test may occur concurrently with the FAT. Network performance monitoring shall continue throughout the 30-day test period.
- b. During this test, operations and PCSI personnel shall be present as required. The PCSI is expected to provide personnel for this test who have an intimate knowledge of the hardware and software of the system. Coordinate PCSI staffing requirements during the 30-day test to coincide with normal shift operations as much as possible. Off-shift emergencies shall be fully supported by PCSI staff. Provide PCSI staff with cell phones or other mobile communication devices to ensure that support staff are available by phone and on-site within 4 hours following a reported problem from operations staff.
- c. While this test is proceeding, Owner shall have full use of the system. Only plant operating personnel shall be allowed to operate equipment associated with live plant processes. Operations shall remain the responsibility of Owner and the decision of Owner's operators regarding operations shall be final. Only Owner operating personnel shall be allowed to operate equipment associated with live plant processes.
- d. Any malfunction during the tests shall be analyzed and corrections made by the PCSI. The Engineer will determine whether any such malfunctions are critical and warrant a repeat of this test. Network performance excursions that exceed the maximum levels for errors developed by the PCSI and specified herein shall constitute a system malfunction.
- e. Any malfunction, during this 30 consecutive day test period, which cannot be corrected within 24 hours of occurrence by the PCSI's personnel, or more than two similar failures of any duration, will be considered as a non-field-repairable malfunction.
- f. Upon completion of repairs by the PCSI, the test shall be repeated as specified herein.
- g. In the event of rejection of any part or function, the PCSI shall perform repairs or replacement within 10 days.
- h. All computer equipment, network equipment, controllers, database, process controller logic, and graphical interface system must be functioning as required per the specifications prior to the start of each test period. The 30-day test will not be considered successful until all database points and logic functions are tested and verified to be correct.
- i. The total availability of the system shall be greater than 99.5 percent during this test period. Availability shall be defined as:

$$\text{AVAILABILITY} = (\text{TOTAL TIME} - \text{DOWN TIME}) / \text{TOTAL TIME}$$

- j. Downtimes due to power outages or other factors outside the normal protection devices or backup power supplies provided, shall not contribute to the availability test times above.

3.02 TRAINING

- A. The cost of training programs to be conducted with plant personnel shall be included in the Contract price. The training and instruction shall be directly related to the system being supplied. The PCSI is responsible for training associated with the control panels, instrumentation, hardware, and software.
- B. The training program shall represent a comprehensive program covering all aspects of the operation and maintenance of the system.
- C. All training schedules shall be coordinated with, and at the convenience of the Owner. The training classes shall be scheduled a minimum of 2 weeks in advance of when they are to be given. Each training class shall be conducted twice during separate weeks and at different times to allow for the scheduling of shift-based Owner personnel.
- D. Proposed training material, including a detailed outline of each lesson, shall be submitted for review at least 30 days in advance of when the lesson is to be given. Submitted shall be reviewed for suitability and comment provided that shall be incorporated into the course.
- E. Each training class shall be a minimum of eight (8) hours in duration. Separate classes shall be conducted for the Owner's maintenance and operating personnel as required by and at the convenience of the Owner. Maintenance classes shall stress troubleshooting, repair, calibration, and other technical aspects of the control system. Operator classes shall stress operational theory and use of the HMI display screens for monitoring and controlling the processes.
- F. Training shall include both off-site, classroom training and on-site training.
 - 1. Off-site (classroom) training shall be performed a maximum of six weeks prior to the commissioning of the FAT. Classroom training shall be held at the PCSI fabrication facility or at a local facility a maximum of 120 miles from the Owner's headquarters whichever is closer. Classroom training shall include individual sessions covering the following:
 - a. PAC software configuration including logic and database development, programming standards, variable addressing, alarming, analog scaling, diagnostics, and troubleshooting.
 - b. HMI software configuration including database development, displays, alarming, analog trending, diagnostics, and troubleshooting.
 - c. Communication system including system configuration, system architecture, equipment familiarization, diagnostics, and troubleshooting.
 - d. Station operational theory including control panel and HMI operational characteristics.
 - 2. On-site (field) training shall be performed at the project site following successful completion of the FAT, during the 30 – day acceptance test period. On-site testing shall include individual sessions covering the following:
 - a. Detailed hands-on instruction to the Owner operations personnel covering; system operations including manual and automatic operational functionality of each control panel, PAC, and HMI. Operational training shall also include field instrumentation provided under this Contract.
 - b. Address field debugging, troubleshooting, maintenance procedures, calibration procedures suitable for performance by operations staff.

- G. The PCSI shall provide detailed manuals to supplement the training courses. The manuals shall include specific details of equipment supplied and operations specific to the project.
- H. The following specific training sessions shall be provided as part of this Contract. ***[Add a training matrix which outlines each training session below.]***

Session	Topic	Target Audience	Duration

- I. The PCSI shall make use of teaching aids, manuals, slide/video presentations, etc. Training sessions shall be recorded. Recordings shall be prepared in electronic format and viewable on Windows compatible computers. After the training services, such materials shall be delivered to the Owner.

END OF SECTION

SECTION 40 80 01
TESTING GRAVITY FLOW PIPELINES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Acceptance testing of gravity flow, sanitary sewer, storm drain pipelines, including:
 - 1. Visual inspection of pipes.
 - 2. Leakage testing of pipes.
 - 3. Leakage testing of manholes.

1.2 REFERENCED SECTIONS

- A. Section 01 33 00 -Submittal Procedures

1.3 PERFORMANCE REQUIREMENTS

- A. Perform leakage testing to verify compliance with the maximum allowable leakage criteria specified in this Section. Refer to tables in this Section for leakage criteria.
- B. Repair or replace sections of pipelines and manholes that fail to meet the specified requirements and retest until the leakage criteria is satisfied.

1.4 SUBMITTALS

- A. Comply with Section 01 33 00.
- B. Before testing begins and in adequate time to obtain approval through the submittal process, prepare and submit a test plan for review by the Engineer. Include testing procedures, methods, equipment, and tentative schedule.
- C. Submit test reports for each test on each segment of pipeline.

1.5 SEQUENCE AND SCHEDULING

- A. Perform testing after placing and compacting Bedding Material around the pipe, or after backfilling the pipe trench, at Contractor's option. Schedule testing so that no more than 1,000 lineal feet of installed gravity flow piping remains untested at any one time.
- B. Coordinate testing schedules with Owner. Perform testing under observation of Owner.

PART 2 - NOT USED

PART 3 - EXECUTION

3.1 PREPARATION

- A. Provide labor, equipment, tools, test plugs, risers, air compressor, air hose, pressure gauges and other devices necessary for proper testing and inspection of pipelines.
- B. Test pressures shall account for ground water elevation.

3.2 TESTING LINE AND GRADE

- A. Confirm pipe alignment visually by flashing a light between manholes. Verify if alignment is true and no pipes are misplaced. In case of misalignment or damaged pipe, remove and re-lay or replace pipe segment.

3.3 LEAKAGE TESTING

A. Test Options:

1. Test gravity flow, sanitary sewer and storm drain pipes and manholes for leakage.
 - a. Gravity flow pipelines 24-inches in diameter and smaller may be tested by either hydrostatic means or by low pressure air testing.
 - b. Test gravity flow pipelines larger than 24-inches in diameter by hydrostatic means, low pressure air testing or joint testing.

B. Compensating for Ground Water Pressure:

1. When Contractor elects to test pipe after backfilling the pipe trench, groundwater pressure must be taken into account to eliminate influence on the leakage test.
2. Determine groundwater elevation as follows:
 - a. Install a 1/2-inch diameter pipe nipple, approximately 10" long, through the wall of each manhole. Cap the end of the pipe nipple that protrudes into the manhole. Locate pipe nipple at the crown of the new gravity pipeline where the pipeline enters the manhole. Install pipe nipple at the same time the gravity pipeline is constructed.
 - b. Before performing pipeline leakage acceptance test, remove the cap from the pipe nipple and clear the pipe nipple with air pressure. Connect a clear plastic tube to the nipple, run the tube vertically inside the manhole and allow groundwater to rise in the tube.
 - c. After groundwater stops rising, measure the height in feet of water over invert of the pipe.

3.4 HYDROSTATIC LEAKAGE TESTS

- A. Determine groundwater elevation.
- B. Plug wyes, tees, stubouts, laterals and other connections to the sewer. Plug sewer pipeline in the downstream manhole. If necessary to isolate flow, plug incoming pipes in the upstream manhole.
- C. When test pressures require installation of a riser pipe, connect riser pipe to pipe in the upstream manhole.
- D. Fill sewer pipe and manholes with water to the specified test elevation, compensating for the measured groundwater elevation.

3.5 LOW PRESSURE AIR TESTING

- A. Conduct air pressure testing in accordance with ASTM C924.
- B. When low pressure air testing is used to test concrete pipes, a wetted pipe interior is recommended.
- C. Pressurize the pipe section to be tested to 4.0 pounds per square inch and hold this pressure for 5 minutes. After this time period, allow pressure to drop.
- D. When internal air pressure reaches 3.5 pounds per square inch, begin measuring rate of air pressure loss. Record the time interval required for the internal air pressure to drop from 3.5 psi to 2.5 psi.

- E. Acceptance Criteria: The pipeline under test is acceptable when the time interval so recorded exceeds the minimum test time given by the following table:

MINIMUM Time Allowed for Pressure Loss from 3.5 psig to 2.5 psig:	
Nominal Pipe Diameter, Inches	Minimum Time Allowed per 100 Lineal Feet of Pipe Under Test, Minutes
6	0.7
8	1.2
10	1.5
12	1.8
15	2.1
18	2.4
21	3.0
24	3.8

- F. Any section of pipe which fails to meet requirements shall be repaired and retested.

3.6 LEAKAGE TESTING FOR MANHOLES

- A. After completion of manhole construction, wall sealing, or rehabilitation, test manholes for water tightness using hydrostatic or vacuum testing procedures.
1. New Manhole Construction: Conduct test prior to backfilling.
- B. Plug influent and effluent lines connected to manhole with suitably-sized pneumatic or mechanical plugs.
1. Utilize plugs that are properly rated for pressures required for test.
 2. Place plugs a minimum of 6 inches outside of manhole walls.
 3. When pipes connected to the manhole have not been backfilled, brace pipes to prevent dislodging from the manhole.
- C. Vacuum Testing:
1. Install vacuum tester head assembly at top access point of manhole and adjust for proper seal on straight top section of manhole structure. Following manufacturer's instructions and safety precautions, inflate sealing element to the recommended maximum inflation pressure; do not over-inflate.
 2. Evacuate manhole with vacuum pump to 10" mercury (Hg), disconnect pump, and monitor vacuum for the time period specified in the following table.

Depth in Feet	Time in Seconds by Manhole Diameter		
	48"	60"	72"
4	10	13	16
8	20	36	32
12	30	39	48
16	40	52	64

Depth in Feet	Time in Seconds by Manhole Diameter		
	48"	60"	72"
20	50	65	80
24	60	78	96
(a)	5	6.5	8.0
(a) Add times for each additional 2-feet of manhole depth. (The values listed above have been extrapolated from ASTM C924-85).			

3. If the drop in vacuum exceeds 1" Hg over the specified time period tabulated above, locate leaks, complete repairs necessary to seal manhole and repeat test procedure until satisfactory results are obtained.

D. Hydrostatic testing:

1. Fill manhole with water to top of frame. Add water over a 24-hour period to compensate for absorption and evaporation losses. After 24 hours, refill to top of frame and observe for loss of water. If, after a 4-hour period the water level is reduced by more than 1/4", the leakage shall be considered excessive. Contractor shall make necessary repairs and retest the manhole.
2. If water loss exceeds amount tabulated above, locate leaks, complete repairs necessary to seal manhole and repeat test produce until satisfactory results are obtained.

END OF SECTION

SECTION 40 80 02
TESTING PRESSURE PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Hydrostatic pressure pipeline testing.

1.2 REFERENCED SECTIONS

- A. The following Sections are referenced in this Section:
 - 1. Section 01 52 00 – Construction Facilities and Utilities
 - 2. Section 01 99 00 – Reference Forms

1.3 SUBMITTALS

- A. Testing Schedule and Notification of Testing: Submit advance written notice of testing activities a minimum of 48 hours prior to conducting piping tests.
- B. Testing Plan: Submit a written plan that identifies the methods for water procurement, conveyance and disposal.
- C. Completed Pipe Test Record Forms, found in Section 01 99 00.

1.4 TESTING REQUIREMENTS

- A. Furnish personnel, materials, bulkheads, test plugs, restraints, anchors, temporary connections, pumps, pressure gauges and other equipment needed to perform testing.
- B. Water for Testing
 - 1. Use potable water for pressure testing pipelines. Obtain water from the source identified in Section 01 52 00.
 - 2. Disposal:
 - a. Obtain approvals from the Oregon Department of Environmental Quality and other regulatory agencies to dispose of water in existing drainage ditches and other surface water features. Pay all costs to convey or transport water to the point of disposal.
 - b. Dispose of water used for testing pipelines in the sewer collection system or per Paragraph 1.04.B.2.a above.
- C. Test only those portions of the pipe that have been installed as part of this Contract.
 - 1. Test new pipe sections prior to making final connection to existing piping.
 - 2. Install test plugs or bulkheads to isolate new piping systems.
 - 3. Unless otherwise indicated, valves may not be used to isolate portions of the piping system for purposes of testing. When testing against a valve is indicated or approved by the Owner, provide a test plate “pancake” to further isolate the new and existing piping.
- D. Sequence
 - 1. Buried Pressure Piping: Except as otherwise indicated, conduct piping pressure test after trench has been backfilled to subgrade and compacted. Piping may be tested before or after final paving, at Contractor’s option.

2. Encased Piping: Test before encasing pipe in concrete.
- E. Failed Tests: Make necessary corrections or remove defective pipe or defective appurtenances. Repeat pressure test until a successful test is achieved.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. Test pipelines, appurtenances, valves, and fittings in the pipeline system.
- B. Where allowable leakage rates are not specifically indicated, no leakage is allowed.
- C. Perform testing operations in the presence of the Engineer.
- D. Prior to pressure testing, clean pipeline of debris, construction materials, dirt and other foreign material within the piping system.
- E. Do not test pipelines until thrust restraint devices have been installed. Where concrete thrust blocks are used, do not begin pressure test until concrete has attained an age of at least 7 days unless otherwise approved by the Owner. Pressure test buried pipe after backfill.
- F. After testing has been completed, drain test water from pipelines and leave in clean condition.

3.2 FILLING PIPING SYSTEMS WITH WATER

- A. Place temporary bulkheads in the pipe at the ends of the test section, and then slowly fill the pipeline with water at a rate which does not cause surges or exceed the rate at which the air can be released through the air valves.
- B. Ascertain that test bulkheads are suitably restrained to resist the thrust of the test pressure without damage to, or movement of, the adjacent pipe.
- C. Purge air within the pipeline during the filling operation. Check proper operation of air release valves and air vents during the filling operation to ascertain proper operation and venting of air from the pipeline.
- D. Concrete pipe, cement-mortar lined pipe and other pipe made from water absorbing material:
 1. After the filling operation is complete, allow the filled pipeline to stand under a slight pressure for at least 24 hours to allow air to escape from any air pockets within the pipeline and the pipe lining to absorb water.
 2. Examine bulkheads, valves and connections for leaks during this period. If leaks are found, make corrections before conducting the pressure test.

3.3 PRESSURE TESTING EXPOSED PIPING

- A. Test exposed piping as follows:
 1. Fill section of piping under test with water and raise the system pressure to a test pressure of 150 psi.
 2. Visually inspect exposed pipe joints, joints at fittings, valves, hydrants, and other piping appurtenances for leaks.
 3. Correct leakage as necessary to eliminate the leakage.
 4. Duration of Pressure Test: 2 hours.

5. Leakage Allowances: Zero leakage.
6. Correct any visible leakage by tightening flanges and screwed joints, replacing gaskets or removing defective materials.
7. Repeat test until no leakage is observed.
8. Record results of pressure test on Pipe Test Record form, included in Section 01 99 00.

3.4 PRESSURE TESTING BURIED PIPING NON-HDPE

A. For pressure testing of HDPE pipe, See Paragraph 3.05. For other buried pipe materials, pressure test as follows:

1. Fill section of piping under test with water and raise the system pressure to a test pressure of 150 psi. The test pressure shall not be allowed to drop below 150 psi for the duration of the test. If the test pressure drops below 150 psi at any time, the test will be void.
2. The test pressure shall be calculated for the point of highest elevation of the water line but shall not exceed 200 psi at any point
3. Visually inspect exposed pipe joints, joints at fittings, valves, hydrants, and other piping appurtenances for leaks. The use of bell repair clamps or other similar devices to stop leaks due to defective materials or poor workmanship will not be permitted.
4. Correct visible leaks necessary to eliminate the leakage.
5. Duration of Pressure Test: 2 hours.
6. Leakage Measurement:
 - a. Begin test once visible leaks have been eliminated.
 - b. Maintain test pressure during the test period by adding makeup water to a calibrated test reservoir.
 - c. Accurately measure the volume of makeup water introduced into the pipeline to maintain the test pressure to determine the leakage rate for the test.
7. The pipeline pressure test is successful when the makeup water added during the test is equal to or less than the allowable leakage rate (L) defined below.
8. Gasketed Ductile Iron Pipe (mechanical or push-on joint)

$$L = \frac{SD(P)^{1/2}}{148,000}$$

L = Allowable leakage in gallons per hour.

S = Length of the test section in feet.

D = Nominal diameter of the piping in inches.

P = Test pressure in pounds per square inch gauge.

9. Steel Pipe (AWWA C200, Concrete Bar Wrapped Cylinder Pipe (AWWA C303)
 - a. Gasketed joints:
 - 1) L= 6.25 gallons/inch diameter/mile/24 hours
 - 2) L= allowable makeup water in gallons.
 - b. Welded joints: No leakage allowed.

- c. Where pipeline consists of a combination of welded and gasketed joints, adjust the formula above by the ratio of the joint types over the test section.
10. Polyvinyl Chloride (PCV) pipe:

$$L = \frac{ND(P)^{1/2}}{7,400}$$

L = Allowable leakage in gallons per hour.

N = Number of joints in the length of pipeline to be tested.

D = Nominal diameter of the piping in inches.

P = Test pressure in pounds per square inch gauge.

11. Record results of pressure test on Pipe Test Record form, included in Section 01 99 00.

3.5 PRESSURE TESTING HDPE PIPING

A. Pressure test as follows:

1. Tests should be conducted in accordance with Chapter 9 of AWWA M55 and the following:
 - a. HDPE and DI pipes shall be pressure tested separately before tie-in connections. All tie-in joints between HDPE and DI pipe shall be visually inspected at working pressure. Leaks at joints shall be repaired and re-inspected. Test all HDPE water mains and appurtenances including HDPE to DI transition fittings under a hydrostatic pressure equal to 150 psi.
 - b. The Contractor shall schedule pressure testing such that pressure changes due to thermal expansion or contraction of the pipe during the test period is minimized.
 - c. Fill section of piping under test completely. The test section is usually filled from the lowest point of the pipeline and at a slow fill rate to minimize air entrainment. After filling, allow time for the system to reach thermal equilibrium and allow for any dissolved air to exit the system air vents.
 - d. Gradually pressurize the test section to 150 psi and add make-up water as necessary to maintain pressure in the pipeline within 5 psi of the test pressure for a period of four (4) hours. During this initial expansion phase, polyethylene pipe will expand slightly due to elasticity and Poisson effects. Additional test liquid will be required to maintain pressure. The amount of additional test liquid will vary because expansion in the PE pipe is not linear.
 - e. If test pressure cannot be attained, or if it takes an unreasonably long time to reach test pressure, there may be faults such as excessive leakage, entrapped air, or open valving, or the pressurizing equipment may be inadequate for the size of the test section. If such faults exist, discontinue pressurizing and correct them before continuing.
 - f. Immediately following the initial expansion phase, reduce test pressure by 10 psi and stop adding test liquid. Monitor the pressure for 1 hour.
 - g. If no visual leakage is observed and test pressure remains steady (within 5% of the target value) for one (1) hour, no leakage is indicated.
 - h. Under no circumstances should the total time for initial pressurization and time at test pressure exceed eight hours at 1.5 times the system pressure rating. If the test is not complete because of leakage, equipment failure, or any other reason within this total time, the test section should be

depressurized and allowed to “relax” for at least eight hours before starting the next testing sequence.

- i. Record results of pressure test on Pipe Test Record form, included in Section 01 99 90.

END OF SECTION

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SECTION 41 22 13.13
OVERHEAD CRANES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Requirements for Overhead Cranes.

1.2 REFERENCED SECTIONS

- A. The following Sections are referenced in this Section:

1. Section 01 43 33, Manufacturers' Field Services
2. Section 01 61 00, Common Product Requirements
3. Section 01 78 23, Operation and Maintenance Data
4. Section 01 81 00, Equipment and System Testing, Startup and Demonstration
5. Section 09 90 00, Painting and Coating.
6. Section 13 34 19, Metal Building Systems.

1.3 REFERENCES

- A. The following is a list of standards which may be referenced in this Section:

1. American Society of Mechanical Engineers (ASME):
 - a. B30.2, Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist).
 - b. B30.10, Hooks.
 - c. B30.11, Monorails and Underhung Cranes.
 - d. B30.17, Overhead and Gantry Cranes (Top Running, Single Girder).
 - e. HST 1M, Performance Standard for Electric Chain Hoists.
 - f. HST 2M, Performance Standard for Hand Chain Manually Operated Chain Hoists.
 - g. HST 4M, Overhead Electric Wire Rope Hoists.
2. Crane Manufacturer's Association of America (CMAA):
 - a. 70, Electric Overhead Traveling Cranes.
 - b. 74, Top Running & Under Running Single Girder. Electric Overhead Traveling Cranes.
3. National Electrical Manufacturer's Association (NEMA):
 - a. MG 1, Motors and Generators.
 - b. 250, Enclosures for Electrical Equipment (1,000 volts maximum).
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. Occupational Safety and Health Act (OSHA).
6. UL: 674, Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.

1.4 DESIGN REQUIREMENTS

- A. Top-Running Multiple-Girder Overhead Traveling Crane: CMAA No. 70 and ASME B30.2 and B30.17.
- B. Top-Running and Underhung Single-Girder Overhead Traveling Cranes: CMAA No. 74, and ASME B30.11.
- C. Trolley Service Class: CMAA No. 70.
- D. Wire Rope Hoist Service Class: ASME HST 4M and CMAA No. 70 or CMAA No. 74.
- E. Chain Hoist Service Class: ASME HST 1M and CMAA No. 70 or CMAA No. 74.
- F. Hook: ASME 30.10.
- G. Building Clearances: CMAA No. 70 and CMAA No. 74. Where bridge span exceeds 40 feet, increase clearance to 6 inches.
- H. Stress and Safety Factors: CMAA No. 70 and CMAA No. 74. Properly select materials of construction for stresses to which subjected.
- I. Safety of Operation, Accessibility, Interchangeability, and Durability of Parts: ASME B30.2.0 and OSHA requirements. Design equipment for environment operated.
- J. Provide system, equipment, and components, including supports and anchorages, designed in accordance with Section 01 61 00.

1.5 SUBMITTALS

- A. Action Submittals:
 - 1. Shop Drawings:
 - a. Make, model, weight, and horsepower of each equipment assembly.
 - b. Complete catalog information, descriptive literature, materials of construction, and specifications on bridge drive system, end trucks, runway stops, footwalks and platforms, wheels, shafting, drive motor, gears and bearing, steel framing, trolley drive system, hoist motor and assemblies, hook, brakes, starting system,
 - c. variable speed drive system, conductors (bus bar, festoon, cable reel), controls, remote control system, and accessories.
 - d. Detail Shop Drawings of crane runways, brackets, hangers, and their attachments to building structural steel.
 - e. Power and control wiring diagrams, including terminals and numbers.
 - f. Motor nameplate data in accordance with NEMA MG 1 and include any motor modifications.
 - g. Factory finish system.
- B. Informational Submittals:
 - 1. Special shipping, storage and protection, and handling instructions.
 - 2. Manufacturer's printed installation instructions.
 - 3. Manufacturer's Certification of Compliance that the factory finish system is identical to the requirements specified herein.
 - 4. Factory Functional Test Report.
 - 5. Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

6. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
7. Operation and Maintenance Data: As specified in Section 01 78 23.
8. Manufacturer's Certificate of Proper Installation, in accordance with **Section 01 43 33**.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Temperature: Maximum 110 degrees F; minimum 40 degrees F.
- B. Humidity: 50 percent.
- C. Atmosphere: Indoor dry.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Crane manufacturer to coordinate equipment requirements with steel structures, panels, drive motor, control panel, trolley and hoist, hoisting cable or chain, hook, crane mounted conductors, rails, stops, and electrical equipment controls.
- B. Where adjustable speed drives or remote control systems are required, crane manufacturer to furnish a coordinated operating system.

2.2 SUPPLEMENTS

- A. See supplements to this Section for additional requirements.

2.3 RUNWAY

- A. Runway beams, brackets, and associated framework furnished under **Section 13 34 19**.
- B. Runway rails shall conform to cross-sections and weights per yard as specified in CMAA No. 70 or CMAA No. 74. Furnish rails, crane stops, and conductors by crane manufacturer. Floating rails are not acceptable.

2.4 BRIDGE

- A. Furnish girders from structural shapes proportioned to resist vertical, lateral, and torsional forces.
- B. Construct bridge end trucks in accordance with CMAA No. 70 or CMAA No. 74. Furnish end trucks with rail sweeps and impact-absorbing bumpers.
- C. Furnish runway stops attached to resist force applied when contacted and locate at limit of travel of bridge. Runway stops shall not engage the wheels.
- D. Provide bridge travel limit switches, located approximately 10 feet to 15 feet from each end of bridge runway, or as required such that bridge travel speed is reduced to low speed prior to bridge engaging runway end-stops. Bridge drive speed past the limit switch locations shall be limited to low speed.
- E. For top running cranes, provide footwalk of antislip plate, with toe guard, trussed handrails, and live load in accordance with CMAA No. 70 or CMAA No. 74 and ASME B30.2. Footwalk shall be full crane width and provide access to trolley, hoist, bus bar, and electrical boxes.
- F. Wheels: Rolled or forged steel with treads and flanges heat treated, or cast iron wheels with chilled tread. Minimum tread hardness 200 Brinell. Clearances, wheel loads, and tolerances in accordance with CMAA No. 70 or CMAA No. 74. Wheel axles of alloy steel, machined and ground to receive inner bearing races. Use rotating axles and wheels

mounted by press fit and keys. For top-running cranes provide rotating axles and wheels mounted by press fit and keys.

- G. Bridge driving machinery consisting of a cross shaft driven by an electrical motor through a gear speed reducer unit. Cross shaft, high-grade steel, turned, ground, polished, and adequately supported with self-aligning bearings. Shaft diameter to resist torsional strains when bridge is traveling under full load, or when stopped suddenly. Furnish oil-tight speed reducer gear case and support on common base with bridge brake.
- H. Drive Gears: Helical, spur or herringbone type, rolled or cast steel, with machine cut teeth.
- I. Bearings: Combination radial and thrust type, double row, spherical ball, either prelubricated and sealed or fitted for pressure lubrication. Pressure lubrication fittings for maintenance accessibility.
- J. Lubrication: As crane is located over a pump station wet well for drinking water supply, lubricants used shall be certified as food grade.
- K. Brakes: Electrically operated, adjustable, suitable for the service class indicated, with rated torque capacities as specified in CMAA No. 70 or CMAA No. 74.

2.5 TROLLEY

- A. Frame: Welded steel, cast steel, or ductile iron construction, or a combination thereof. Design to control deflection of trolley assembly while transmitting the carrying load to bridge rails.
- B. Drive shall consist of trolley drive shaft, driven by an electric motor through a gear reduction unit.
- C. Furnish roller assembly stabilizers on single-girder trolley units to prevent tipping during load pickup.
- D. Wheels: Rolled or forged steel, accurately machined and ground to receive inner bearing races. Furnish alloy steel axles. Rotating axles with wheels mounted press fit and keys, or with keys alone. Minimum tread hardness 210 Brinell.
- E. Drive Gears: Helical, spur or herringbone type, rolled or cast steel, with machine cut teeth.
- F. Bearings: Combination radial and thrust type, double row, angular contact ball bearings or single-row tapered roller bearings. Bearings prelubricated and sealed, or fitted for pressure lubrication. Locate pressure lubrication fittings for accessibility during maintenance.
- G. Lubrication: As crane is located over a pump station wet well for drinking water supply, lubricants used shall be certified as food grade.
- H. Brakes: Suitable for service class and rated torque capacities as specified in ASME B30.11. Furnish stops on trolley rails or beams.
- I. For bridge spans greater than 40 feet provide trolley travel limit switches, located approximately 6 feet to 8 feet from each end of trolley rails/beams, or as required such that trolley travel speed is reduced to low speed prior to trolley engaging the trolley end-stops. Trolley drive speed past the limit switch locations shall be limited to low speed.

2.6 HOIST

- A. Hoisting machinery shall consist of rope drum driven through gear reductions, load blocks, hook, hoisting rope, sheaves, and hoist braking. Drum size and length sufficient for minimum two turns of cable remaining on drum when hook is at lowest position. Furnish reeving as specified on supplement located at end of section. Provide right and left-hand grooved drum when two-part double reeving is specified.

- B. Rope drum and surrounding members constructed to minimize abrasion, crushing or jamming of hoist rope. Load blocks enclosed type. Hoisting rope extra flexible, improved plow steel wire rope, made especially for hoist service.
- C. Hook: Construct with sufficient ductility to open noticeably before hook failure, equipped with safety latch, free to rotate 360 degrees with rated load and positively held in place with locknuts, collars or other devices.
- D. Brakes: Mechanical and electric load brake and controls, designed in accordance with ASME 4M, and adjustable to compensate for wear.
- E. Hoisting Machinery: Load chain wheel driven through gear reductions, an electric motor, load blocks, sheaves, chain, hook, and hoist braking.
- F. Lubrication: As hoist is located over a pump station wet well for drinking water supply, lubricants used shall be certified as food grade.
- G. Hook: Construct with sufficient ductility to open noticeably before hook failure, equipped with safety latch, free to rotate 360 degrees with rated load, and positively held in place with locknuts, collars or other devices.
- H. Brakes: In accordance with ASME HST 1M and HST 2M, adjustable to compensate for wear, positive action, Weston type mechanical load brake, with uniform composition lining and forged steel alloy latch awl.

2.7 ELECTRICAL

- A. Furnish electrical equipment including motors, motor starters, pendant control, control systems, wire, and conduit. Bridge conductors may be removed for shipment. Crane wiring by crane supplier.
- B. Electrical: In accordance with NFPA 70, NEC Article 610.
- C. Furnish motors compatible with adjustable frequency, variable speed, drive system, 40 to 1 speed range, suitable for hoist, trolley, and bridge drive applications. Controls with 120V ac, microprocessor based, pulsed width modulation design, withstand 45 degrees C temperatures, housed in NEMA 250, Type 4 enclosure, and supplied with 200 percent overcurrent protection.
- D. Manufacturer: P & H Smartorque.
- E. Bridge and trolley conductor voltage drops from runway supply taps shall permit the crane motors to operate within voltage tolerances of plus or minus 10 percent, when building supply voltage is at plus or minus 5 percent of design voltage.
- F. Enclosed Bus Bar Conductors: Galvanized steel strip enclosed in insulation. Collector sliding shoe type, with adjustable spring tension arms for contact between bus bar and controls.
- G. Festooned Flat Cable Conductors: Flexible cable, carried by heavy-duty roller, permanently lubricated roller bearings, with monorail support system that will dispense and retrieve flexible cable without twisting or tangling, and
- H. 20 percent spare conductor in each cable assembly.
- I. Grounding: External in accordance with NFPA 70, NEC Article 250.

2.8 CONTROLS

- A. Furnish electric cranes with pendant control having momentary contact push buttons with a device which will disconnect motors from line on failure of power. Device shall not permit any motor to be restarted until controller handle is brought to the OFF position, or a reset

switch or button is operated. Furnish with undervoltage protection as a function of each motor controller, or by magnetic main line contactor.

- B. Controls: Fully magnetic, plain reversing type, housed in NEMA 250,
- C. Type 12 enclosure, with contactors of sufficient size and quantity for starting, accelerating, reversing, and stopping duty for specified crane service class.
- D. Bridge and Trolley Drives: Soft start controls, 460/230V ac series device, installed in between drive motor and motor starter with torque and acceleration rate adjustable, suitable for crane service, and work in conjunction with crane controls.
- E. Pushbutton Control Stations: Heavy-duty, oil-tight, suspended from trolley with control transformers to supply 120V ac power to pushbutton control station. Pushbutton enclosure supported with chain or wire rope. Control wirecable attached to support chain or wire rope at not more than 6-foot intervals. Furnish control station buttons for control of bridge, trolley, and hoist, ON/OFF main line contactor power switch which removes all power from crane and controls.
- F. Control motions indicate direction of resultant crane motion. Furnish spring-loaded switch motions, with return to OFF position when switch is released and designed to prevent runaway crane situations.

2.9 ACCESSORIES

- A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location. Mounted on separate components of each crane assembly, to facilitate assembly in the field.
- B. Lifting Lugs: Equipment weighing over 100 pounds.

2.10 FACTORY FINISHING

- A. Prepare and prime coat in accordance with Section 09 90 00 manufacturer's standard.

2.11 SOURCE QUALITY CONTROL

- A. Factory Inspections: Inspect control panels and equipment for required construction, electrical connection, and intended function.
- B. Factory Tests and Adjustments: No-load run test all equipment furnished.
- C. Factory test report shall include Test Data Sheets.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions.
- B. Provide lubrication and lubrication fittings.

3.2 FIELD FINISHING

- A. Equipment as specified in Section 09 90 00.

3.3 FIELD TESTING

- A. In accordance with Section 01 81 00.
- B. Conduct tests on each unit.
- C. Component Testing:

1. Perform Component Testing in accordance with Section 01 81 00.
 2. Component Equipment Testing shall consist of basic equipment inspection and testing completed under both “dry” and “wet” conditions to establish proper connectivity, functionality, and operability, with a goal of confirming readiness to move to Systems Testing in “wet” conditions.
 3. Functional Testing:
 - a. Prior to Systems Testing, test complete assemblies for proper alignment and connection, and quiet operation, and specified performance.
 - b. Includes testing of all control functionality:
 - 1) Local – Manual.
 - 2) All equipment controls, hard-wired interlocks.
 - 3) All External Interfaces:
 - a) All equipment status and monitoring points to/from the equipment.
 - b) All alarms to/from the equipment.
 - c) All setpoints to/from other systems.
 - c. Testing shall be conducted with all network connections to equipment completed, fully terminated, and successfully communicating to other systems.
 4. Performance Test:
 - a. Conduct on each crane.
 - b. Load tests in compliance with OSHA, ASME B30.11, and ASME B30.16.
- D. Systems Testing:
1. Perform Systems Testing in accordance with Section 01 81 00.
 2. During systems testing, individual process units and systems shall be independently tested and evaluated in a wet environment (i.e., in an environment similar to normal operating conditions) to confirm basic functionality and that the controls are performing as designed.
 3. Includes testing of all control functionality:
 - a. All Control, Monitoring, Alarm, and Network Functions:
 - 1) All interlocks.
 - 2) All status, monitoring, alarms, and control functions.

3.4 MANUFACTURER'S SERVICES

- A. See Section 01 43 33 and Section 01 81 00.
- B. Provide training to operations and maintenance personnel per Section 01 43 33.

3.5 SUPPLEMENTS

- A. The supplements listed below, following “End of Section,” are a part of this Specification.
 1. Crane Data Sheet.
 2. Crane Dimension Sheet: Building Clearances for Top-Running Cranes.

END OF SECTION

SECTION 43 40 02
FIBERGLASS REINFORCED PLASTIC (FRP) CHEMICAL STORAGE TANKS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Contractor provided labor, materials, equipment, and incidentals required to furnish and install fiberglass reinforced plastic (FRP) tanks and appurtenances for storage of the following chemicals, as shown on the Drawings and as specified:
 - 1. Sodium Hypochlorite (12.5%)
 - 2. Hydrochloric Acid (15%)
- B. In the event of conflict between this specification and the contract drawings, the order of precedence shall be this specification and then the contract drawings.

1.2 REFERENCED SECTIONS

- A. The following Sections are referenced in this Section
 - 1. Section 01 88 15 – Anchorage and Bracing
 - 2. Section 01 99 00 – Reference Forms
 - 3. Section 05 05 01 – Anchor Bolts and Anchoring Devices

1.3 EQUIPMENT NUMBERS

- A. Sodium Hypochlorite Tank 1: TNK-6410
- B. Sodium Hypochlorite Tank 2: TNK-6420
- C. Hydrochloric Acid Tank 1: TNK-6430
- D. Hydrochloric Acid Tank 2: TNK-6440

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications:
 - 1. Manufacturer shall have a minimum of ten years of experience producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.
 - 2. Manufacturer shall hold a valid ASME RTP-1 Certificate of Authorization issued by the American Society of Mechanical Engineers (ASME). ASME RTP-1, 7-800 states "No Fabricator shall claim qualification to fabricate to this Standard until having satisfactorily completed and tested the demonstration vessel..." No exceptions will be allowed to permit non-certified fabricators to build to the ASME standard.
- B. Source Quality Control:
 - 1. Vessels shall meet the requirements as detailed in the manufacturer's pre-approved Quality Assurance Manual and any additional requirements as required in this specification.
 - 2. Owner or Owner's representative reserves the right to witness the fabrication and testing of the equipment at the fabricator's facility of all times while work is being complete. Notice of inspection shall be given prior to commencement of fabrication.

1.5 REFERENCE STANDARDS

- A. Comply with the applicable provisions and recommendations of the following,
 - 1. ASME RTP-1, Latest Edition
 - 2. NSF International (NSF):
 - a. NSF/ANSI 61, Drinking Water System Components – Health Effects.
 - b. NSF/ANSI 372, Drinking Water System Components – Lead Content.
 - 3. American Society for Testing and Materials (ASTM).
 - 4. Underwriters Laboratories (UL).
 - 5. National Fire Protection Association (NFPA).
 - 6. When reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.6 DESIGN REQUIREMENTS

- A. Refer to **Tank Data Sheets** attached to this specification.
- B. Components and materials in contact with drinking water treatment chemicals:
 - 1. Provide certification that wetted components and materials comply with NSF/ANSI 61 and NSF/ANSI 372.

1.7 SUBMITTALS

- A. Detailed literature, specifications, and drawings to show dimensions, make, style, size, type, materials used, design features, internal construction, weights, and any other information required by Engineer for review of FRP tanks and accessories.
- B. Complete design calculations for tanks, supports and pipe supports. Calculations shall be prepared, stamped and signed by a Civil or Structural Engineer registered in the State of California.
- C. Letter from resin manufacturer stating that selected resin(s) is/are suitable for intended service(s).
- D. Qualifications of Fabricator's Quality Assurance Supervisor.
- E. Copy of fabricator's Quality Assurance Program.
- F. Quality Assurance Inspection:
 - 1. Qualifications of Independent FRP Quality Assurance Inspector.
 - 2. Initial QA Inspection Report.
 - 3. Certification of Factory Testing.
- G. Special shipping, storage and protection, and handling instructions.
- H. Fabricator's printed installation and tank support instructions.
- I. Samples: Laminate sample representative of production quality of surface finish and visual imperfections.
- J. Shop Drawings: Submit the following for approval:
 - 1. Service Conditions: Chemical environment and temperature.
 - 2. Resin and materials of construction including thickness of each layer.
 - 3. Details of tie-down systems for all storage tanks and appurtenances.

4. Calculations and certifications by a Registered Professional Engineer stating that the design of the shell, lifting and tie down systems can withstand the intended loads.
5. Dimensions of tanks, fittings, pipe connections, manways and appurtenances.
6. If used, details of FRP ladders, grating and grating support systems and handrails.
7. Total operating weight of each tank and fittings.
8. Tank capacity chart indicating gallons for each inch of depth and cumulative total from bottom.
9. Fabricator's detailed requirements for tank foundations.
10. Recommended bolt torque for bolted FRP connections.
11. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15.
12. Dimensions, orientation and location of nozzles showing details of construction and attachment to tank.
13. Data sheet from resin manufacturer listing nomenclature, composition and characteristics of the resin.
14. Copy of manufacturer's valid ASME RTP-1 Certificate of Authorization.

1.8 DEFERRED SUBMITTALS

- A. Submit complete installation, operation and maintenance manuals including as-built drawings.
- B. Quality Assurance Inspections:
 1. Initial Quality Assurance Inspection Report
 2. Certification of Factory Testing
 3. Manufacturer's Installation Certification Form see Section 01 99 00.
- C. Service records for any repairs performed during construction.

1.9 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Do not ship tank from factory until Engineer review of Certification of Factory Testing is completed.
- B. Be responsible for the safe transportation to the job site, including any freight cost and necessary permits, handling, and open air storage of the tanks and other materials purchased as specified in this Section.
- C. Tanks delivered to the job site shall be inspected immediately by Contractor for damage, unloaded and stored with a minimum of handling. Comply with manufacturer's recommendations in handling and storing tanks. Tanks shall be shipped empty; all interior components shall be shipped separately.
- D. In general, tanks shall be:
 1. Checked and tied down to prevent being blown by wind.
 2. Vented to allow for temperature changes that may affect their integrity.
 3. Provided with opening protection to exclude foreign matter.
- E. The manufacturer shall protect all flange faces and any fragile appurtenances or sub-assemblies, with proper packaging, in order to prevent one piece from impacting with another, and by crating or other means for shipment.

- F. Impact of tools or other heavy objects shall be avoided. Impacts may result in a fracture of the inner lining and affect the service life of the equipment.
- G. Large sub-assemblies should be supported during unloading to prevent excessive deflection and overstressing.
- H. Equipment and materials shall be stored so as to keep free from moisture, damage, and deterioration.
- I. Tanks shall be protected, by padding or bracing, from banding or ropes used in shipment. No chains are to be used to secure any tanks in transportation.
- J. Tanks shall be clearly marked for any precautions in handling and transportation.

1.10 EQUIPMENT INSPECTIONS

- A. Contractor and Engineer shall inspect each piece of equipment upon arrival at construction site to inspect for damage incurred in transit. Any damage shall be noted on the bill of lading and the equipment fabricator will be notified immediately. Fabricator will coordinate the repair.

PART 2 - PRODUCTS

2.1 SUPPLIERS

- A. Tanks shall be designed and fabricated by one of the following suppliers:
 1. Diamond Fiberglass, Victoria, TX
 2. Augusta Fiberglass
 3. Ershigs, Inc.

2.2 SERVICE CONDITIONS

- A. Operating Pressure: 1-inch water column.
- B. Ambient Temperatures: 30 degrees F to 120 degrees F
- C. Installed outside exposed to direct sunlight

2.3 EQUIPMENT DESIGN AND FABRICATION

- A. Tanks shall be designed per ASME RTP-1, Part 3 (3A or 3B as applicable). Vessel major components, shell joints (secondary bond overlays), flanged nozzles, manways and reinforcement of cutouts are fabricated to ASME RTP-1 Latest Edition, Section 4-300 thru 4-600 as applicable using Type I, Type II, or Type X laminates. Corrosion liner thickness is excluded from the structural calculations.
- B. For the vessel major components, chopper gun application is only permitted if an in-process automated resin to glass monitor is used such as TFM or equal. Submit output data from the monitor upon request by Engineer.
- C. Flanged nozzles shall be designed per ASME RTP-1.
 1. Flanges shall conform to ANSI 150 pound standard dimensions for bolting.
 2. Flanges shall be manufactured by hand layup only. Filament wound flanges or flange on pipe fabrications are prohibited.
 3. Blind flanges and access hatches shall be same thickness and materials as flanges to which they are attached.

- D. All tanks and related FRP accessories shall be fabricated in a controlled and well ventilated structure protected from weather and temperature extremes. Entire fabrication, curing and assembly process of any piece of FRP equipment shall be indoors.
- E. Tie-down Ring/Mounting Lugs:
 - 1. FRP or Type 316 stainless steel (integrally assembled to tank).
 - 2. Capable of wind loading per ASCE 7 latest edition (tank empty) for outdoor tanks.
 - 3. Provide three to one safety factor with an increase in allowable stress of one-third against seismic forces as set forth for applicable zoned seismic area in ASCE 7- latest edition for the jobsite location, Site Class D.
 - 4. Engineer shall design and supply all necessary anchor bolts.
 - 5. Mounting ring / tie down lugs shall be factory assembled as part of the tank construction.
- F. [USE IF NECESSARY] Each storage tank shall be furnished with a minimum of two universal lugs installed on the top of the tank. The lugs are to be used to fasten electrical pull boxes thereto. Lugs shall be installed at either the locations shown on the Drawings or where directed by the Engineer.
- G. Each storage tank shall be provided with external integrally-fabricated FRP structural members or struts for mounting and support of pipes, conduits, ladders, walkways, grating systems and handrails if and as shown on the Drawings.
 - 1. The following accessories will require external support clips:
 - a. Fill line
 - b. Overflow
 - c. Sight gage

2.4 MATERIALS OF CONSTRUCTION

- A. Resin
 - 1. The resins used in fabrication shall be premium grade vinyl ester such as Ineos Derakane 411, AOC Vipel F010, or equal.
 - a. For tanks in sodium hypochlorite service used in non- potable water applications, the corrosion liner resin shall be a premium grade brominated vinyl ester, such as Ineos Derakane 510B, or equal. The structural layer resin shall be Ineos Derakane 411, Vipel AOC F010 or equal.
 - b. For tanks in sodium hypochlorite service used in potable water applications, the corrosion liner resin shall be a premium grade vinyl ester, such as Ineos Derakane 411, AOC Vipel F010 or equal.
 - 2. For applications requiring fire-retardant resin, the resin manufacturer's fire retardant version of the resins noted in shall be used.
 - 3. The resin shall not contain fillers unless specified. When specified, up to 5% by weight of thixotropic agent, Cab-O-Sil or equal, may be used for viscosity control in the paraffinated top coat on vertical surfaced, provided it will not interfere with visual inspection. No dyes or pigments will be used unless authorized by the Purchaser.
 - a. Vessels fabricated for sodium hypochlorite service must be fabricated without the use of the above noted thixotropic agents, as the sodium hypochlorite reacts with the thixotropic agents, compromising the corrosion resistance of the vessel.

4. The cure system used for the resin shall be in accordance with the resin Fabricator's current recommendations. Proper curing of the resin is the Fabricator's responsibility.
 - a. All products fabricated to this specification shall be cured to at least 90% of the minimum Barcol hardness specified by the resin Fabricator.
 - b. The use of paraffin in the resin or the use of Nexus veil may lower the Barcols below the resin Fabricator's specifications. In this case, the minimum Barcol shall be established prior to fabrication.
 - c. If minimum Barcols cannot be reached, acceptance of cure may also be demonstrated through differential scanning calorimetry ("DSC testing") on coupons taken from the vessel. DSC testing shall be performed by and certification of resin cure shall be issued by the resin manufacturer.
 - d. Vessels fabricated for sodium hypochlorite service must be fabricated utilizing a BPO/DMA cure system for the corrosion liner and either BPO/DMA or MEKP catalyst system for the structural layer.
5. No chemical-resistant surface, interior or exterior shall be acetone sensitive. A wax containing resin coating, formulated according to the resin Fabricator's most recent recommendations, must be applied over any interior secondary bonds to achieve an air-inhibited cure.

B. REINFORCEMENT

1. One layer of Nexus surfacing veil shall be used to reinforce the inner surface. Thickness of the resin rich inner surface shall be 0.020" to 0.025". Total thickness of the inner surface and interior layer shall be not less than 0.100". Nexus shall be Style 100-10 Apertured 1.5 oz. Dacron polyester fiber 12-16 mils thick as manufactured by Burlington Glass Fabric Company.
2. The interior layer shall be applied in a minimum of two passes of chopped strand roving using automatic fabrication equipment which controls raw material deposition to rotating molds through the use of digital readout programmable controllers for raw material use verification. Resin content of the interior layer shall be 70%, plus or minus 5%.
 - a. A double ply Nexus surfacing veil is required for vessels in sodium hypochlorite service, due to the aggressive corrosion characteristics of sodium hypochlorite. The application of the second ply of veil will increase the inner surface thickness from 0.020" to 0.035". The interior layer reinforcement for sodium hypochlorite shall be boron free ECR type glass as manufactured by Owens Corning ADVANTEX.
3. Structural portion of vessel wall shall utilize continuous winding glass for hoop properties (and unidirectional glass as required for additional axial properties) interspersed with automatically applied chopped glass and resin. Resin to glass content shall be 50/50 plus or minus 5%.

2.5 ACCESSORIES

A. Tank Insulation

1. When specified, vessel to be insulated with 2" thick polyisocyanurate foam, Dow Plastic's Trymer 2000, or equal. For flat bottom tanks, vessel sidewall and top to be insulated [OTHERWISE SPECIFY ALTERNATIVE] Insulation to be covered with a 1/8" thick fiberglass outer protective skin. Sidewall insulation to be 2" thick, 48" by 96" sheet stock foam, scored on 3" centers, to allow wrapping of insulation around the vessel sidewall.

2. Insulation to be banded to vessel utilizing plastic banding straps to insure a tight uniform fit on vessel wall. After completion of insulation placement, the 1/8" thick outer protective FRP skin is to be applied over the insulation.
 3. The vessel's dome top is to be insulated utilizing the same type of insulation supplied in pre-formed shapes to match the curvature of the head's crown and knuckle radius or 2" flexible EPDM insulation. Again, after insulation of the head foam, the 1/8" thick outer protective FRP skin is to be applied over the insulation.
 4. Vessel sidewall to have a minimum of one expansion joint cut into the outer skin to allow for expansion and contraction differences between the vessel wall and outer skin. Joint to be designed to be weatherproof against wind blown rain, etc.
- B. Access Ladder (NOT USED)
- C. Level Measurement:
1. Required as shown on the contract drawings.
 2. Provide liquid level sight gages mounted to side of tank. Liquid level gages shall be clear type or reverse float type with calibrations marked in inches from the bottom of the gage.
 3. [NTS: DO NOT USE REVERSE FLOAT GAGES ON SODIUM HYPOCHLORITE TANKS] If reverse float type gage is used, float must be manufactured of materials resistant to the chemical stored.
 4. [OPTIONAL] Adjacent to the level gage, provide a calibration strip marked in gallons.
 5. Manufacturer shall source the level gage and shop fit to the vessel prior to shipment to ensure proper field fit.
- D. Identification:
1. Equipment Data Nameplate: Permanently attach Type 316 stainless steel. Include the following data on the nameplate:
 - a. Tank Name
 - b. Tag Number
 - c. Customer Name
 - d. PO Number
 - e. Invoice Number
 - f. Serial Number
 - g. Capacity
 - h. Year Built
 - i. Weight Empty
 - j. Diameter
 - k. Sidewall height
 - l. Contents
 - m. Corrosion Liner Resin, Veil, Thickness
 - n. Structural Layer Resin
 - o. Specific Gravity
 - p. Design Pressure
 - q. Design Temperature

2.6 SURFACE PREPARATION AND PAINTING

- A. Fiberglass reinforced plastics tanks shall be gel-coated with a parrifinated resin coat. Gel coat shall contain UV inhibitors.
- B. Tanks in sodium hypochlorite service which are not insulated shall receive a primer coat prior to the top gelcoat. The goal is to maximize opacity in the laminate and reduce light breakthrough to the sodium hypochlorite.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Inspect all concrete pads for proper elevation, dimensions, cutouts, evenness and anchor bolt locations and correct if necessary.
- B. Accurately place anchor bolts using templates furnished by fabricator, and as specified in Section 05 05 01.
- C. Install tanks and equipment as shown on the Drawings, approved Shop Drawings and as directed by the manufacturer's recommendations.
- D. Inspect all tanks prior to installation. If damaged, notify the Engineer and manufacturer promptly. Do not install damaged tanks until repairs are made in accordance with manufacturer's written instructions.

3.2 FIELD TESTS

- A. After installation of storage tanks is complete, but before piping connections are made, block all outlets and fill each tank with potable water. Allow water to stand for 24 hours to verify no leakage. No leakage is permitted.
- B. After installation is complete including pipe connections, clean tank and nozzles with detergent and rinse with 180° F water.
- C. Dry tank completely prior to filling with chemicals.

3.3 FINAL INSPECTION – [OPTIONAL]

- A. At Contractor's expense, provide the Engineer, a detailed inspection report of the final tank installation.
 - 1. The detailed inspection report shall indicate any and all installation deficiencies of the installed tank and show verification of deficiency corrections.
- B. The tank manufacturer's representative shall perform the final inspection.
- C. Completion of report signifies compliance of the installed tank with all warranty requirements of the manufacturers.

END OF SECTION

SECTION 44 42 19.04
ROTARY POSITIVE DISPLACEMENT BLOWER

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. The furnishing, installation and start-up of rotary positive displacement blowers for backwash supply including all appurtenances for complete and functioning air system.
- B. The blowers shall be installed as shown on the Drawings.
- C. Equipment List
 - 1. B-3210
 - 2. B-3220

1.2 REFERENCED SECTIONS

- A. The following Sections are referenced in this Section:
 - 1. Section 01 43 33, Manufacturers' Field Services
 - 2. Section 01 61 00, Common Product Requirements.
 - 3. Section 01 7823, Operation and Maintenance Data
 - 4. Section 01 81 00, Equipment and System Testing, Startup and Demonstration
 - 5. Section 01 88 15, Anchorage and Bracing
 - 6. Section 26 20 00, Low-Voltage AC Induction Motors.

1.3 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. American Gear Manufacturers Association (AGMA).
 - 2. American National Standards Institute (ANSI).
 - 3. ASTM International (ASTM):
 - a. A48/A48M, Standard Specification for Gray Iron Castings.
 - b. A395/A395M, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
 - 4. National Electrical Manufacturers Association (NEMA).

1.4 DEFINITIONS

- A. Absolute Discharge Pressure: Pressure in pounds per square inch absolute (psia) at the blower discharge flange in relation to Job Site barometric pressure.
- B. Brake Horsepower (BHP): (Shaft) Standard curve horsepower required, corrected for pressure, temperature, and relative humidity at inlet conditions.
- C. Discharge Pressure: Pressure in pounds per square inch gauge (psig) at blower discharge flange at rated capacity.
- D. Inlet Cubic Feet per Minute (icfm): Volumetric rate of air at the inlet flange of the blower corrected to absolute pressure, temperature, and relative humidity. The pressure takes into account the inlet piping in filter pressure drops.

- E. Pressure Rise: Pressure developed within the blower between the inlet and outlet flanges. It is the discharge pressure less the inlet pressure measured at the discharge and inlet flanges, respectively.
- F. Standard Cubic Feet per Minute (scfm): Volumetric rate of air measured in standard cubic feet per minute at 68 degrees F, pressure of 14.2 psig, and relative humidity of 36 percent.

1.5 SYSTEM DESCRIPTION

- A. Blower system, featuring rotary positive displacement blower(s) to supply air for the filter backwash process system.
- B. Provide blower system including, but not limited to, blowers, motors, drives, guards, drive couplings, baseplates, vibration isolators, supports, inlet silencers, discharge silencers, bypass silencers, relief valves, flexible connectors, noise enclosures, spare parts, air filter, and miscellaneous appurtenances as necessary.

1.6 DESIGN REQUIREMENTS

- A. Design equipment with due regard to safety of operation, accessibility, and durability of parts, and complying with applicable OSHA, state, and local safety regulations.
- B. Blowers discharge air into filters producing drinking water. Lubricants used in the blower shall meet NSF certification for contact with drinking water or shall be certified as a food grade lubricant.
- C. Each blower will receive outside air from a dedicated filter and discharge into a main air discharge header.
- D. Intermittent and continuous operation in an outdoor, under cover environment.
- E. Blower(s) shall start no more than four times per hour when operating in intermittent service.
- F. Blowers shall meet rated performance and sound level when operating at a maximum gear tip speed of 3,750 feet per minute. Operating speed shall not exceed 80 percent of rated speed.
- G. Maximum Sound Pressure Level: 85 dBA, factory calculated, with inlet and discharge silencers, measured with a sound enclosure.
- H. Performance Requirements:

Design Conditions	
Design Capacity, scfm (Guaranteed air flow at temperature, relative humidity and inlet pressure listed below)	1,920
Design Capacity, icfm	2,097
Altitude, ft	143
Barometric pressure, psia	14.63
Inlet pressure at compressor flange with 0.23 psi inlet filter and piping loss, psia	14.5
Inlet air temperature, degrees F (Guarantee Point)	78
Inlet air temperature range, degrees F	20 min to 106 max
Relative humidity, % (Guarantee Point)	50
Discharge pressure at compressor discharge flange, psia	23.4
Blower pressure rise required, psi	8.0

Pressure relief valve setting, psig	8.3
Shaft brake horsepower, BHP1,2	125
1. Includes main oil pump, if specified, and all gear and bearing frictional losses. 2. Not to exceed motor nameplate horsepower at 1.0 service factor at the minimum inlet air temperature, pressure relief valve setting and inlet pressure listed above.	

1.7 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:

- a. Complete list of system components to be provided.
- b. Make, model, weight, and horsepower of each equipment assembly.
- c. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
- d. Standard and specialized equipment assembly cuts.
- e. Performance data for each type of equipment that will show compliance with specification requirements stated herein.
- f. Horsepower demand over the operating range of the blower.
- g. Detailed structural, mechanical, and electrical drawings showing the equipment fabrications and interface with other items. Include dimensions, size, and locations of connections to other work.
- h. Motor: See requirements of **Section 26 20 00**.
- i. Monitoring System:
 - 1) Catalog cuts of each blower instrument system component.
 - 2) Wiring diagrams and terminal numbers if monitoring instruments are wired to a terminal junction box.
- j. Anchorage and bracing drawings and cut sheets, as required by **Section 01 88 15**.
- k. Sound Enclosure:
 - l. Complete description of sound enclosure and accessories.
 - m. Calculated noise attenuation.
 - n. Details of cooling fan operation and required control, including whether fans need to be powered to cool enclosure after the main blower motor has turned off.
2. Samples: Color samples for finish coating. If paint manufacturer of finish coat differs from manufacturer of prime coat, provide both manufacturers' written confirmation that materials are compatible.
3. Lubricant data that demonstrates NSF certification or food grade rating for lubricants.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance, in accordance with **Section 01 61 00**.
2. Factory calculated sound levels (dBA) of blower unit with silencers and sound enclosure.
3. Identification of outside utility requirements for each component, such as air, water, power, etc. Include operating parameters for required utilities.
4. Special shipping, storage and protection, and handling instructions.

5. Manufacturer's written installation instructions.
6. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
7. Routine maintenance requirements prior to plant startup.
8. Test Reports:
 - a. Factory test reports for blower and motor.
 - b. Field test procedures.
9. Operation and Maintenance Data:
 - a. As specified in Section 01 7823.
10. Manufacturer's Certificate of Proper Installation, comply with Section 01 43 33.

1.8 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following materials:

Item	Quantity
Inlet Filters	Enough for 2 complete changes per unit
Special tools required to maintain or dismantle	One complete set for each unit

B. Delivery: In accordance with Section 01 61 00.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. General:

1. Where possible, provide end products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, replacement, and manufacturer's service.
2. Manufacture spare parts to United States standard sizes and gauges.

B. Materials, equipment, and accessories specified in this section shall be products of:

1. Gardner Denver; Tri-Lobe Series.
2. Roots; Easy Air Tri-Ram Series.
3. Kaeser, Com-paK Series.

2.2 COMPONENTS

A. Blower:

1. Rotary positive displacement type, belt driven by horizontal electric motor.
2. Casing: One-piece construction, ASTM A48/A48M, Class 30B close- grain cast iron strongly ribbed to prevent distortion at the specified operating conditions. Separate headplates of cast iron.
3. Bearings:
 - a. Support shaft and impeller assembly by roller bearings sized for a minimum L10 rating of 100,000 hours.
 - b. Drive End Bearings: Fixed to control axial location of impeller assembly.

- c. Bearings: Grease or oil lubricated. Any lubricants that can get into the air stream shall be NSF certified as safe for contact with drinking water or certified as food grade.
 - d. Gears: Splash oil lubricated. Any lubricants that can get into the air stream shall be NSF certified as safe for contact with drinking water or certified as food grade.
 - e. Provide bearings with a positive lip type oil seal designed to prevent lubricant from entering airstream and a labyrinth seal on each shaft designed to reduce air leakage at point where shaft extends through headplate of blower casing.
 - f. Make further provision to vent area between the two sealing systems to atmosphere to relieve excessive pressure on seals.
4. Impellers:
- a. Provide impeller/shaft assemblies integrally cast from high- strength ASTM A395/A395M Type 60-45-15 ductile iron with a minimum tensile strength of 60,000 pounds per square inch.
 - b. Three-lobe involute type, rotating in opposite directions in a common casing without rubbing, liquid seals, or lubrication.
 - c. Positioned by timing gears to maintain proper clearances.
 - d. Mount impellers and timing gears on shafts supported by antifriction bearings, fixed to control the axial location of impeller/shaft in the casing.
 - e. Statically and dynamically balanced by removing metal from impeller body.
 - f. Positively timed by a pair of accurately machined and carburized steel spur gears hardened to 58-62 Rockwell alloy timing gears manufactured to comply with AGMA. Gears mounted on shafts with tapered fit and secured by locknuts.
5. Shafts:
- a. Cast iron, integral with impellers.
 - b. Machine labyrinth seals into shaft to minimize air leakage.
6. Belt Drive:
- a. V-belt drive with automatic belt tension device.
 - b. Minimum service factor of 1.4.
 - c. Designed not to exceed allowable overhung load limits of blower and motor.
 - d. Provide belt guard.
- B. Motor:
- 1. Squirrel-cage ac induction type, meeting requirements of
 - 2. Section 26 20 00, and as specified herein.
 - 3. Motor Horsepower: 125.
 - 4. Nominal Speed: 1,770 rpm, constant.
 - 5. Rated Voltage: 460-volt, three-phase, 60-Hz.
 - 6. Enclosure Type: TEFC as specified in Section 26 20 00.
 - 7. Provide three high temperature switches wired in series and embedded in each of the motor windings.
 - 8. Motor Efficiency: Premium efficiency as specified in Section 26 20 00.

9. Service Factor: 1.15.
- C. Blower Support:
1. Baseplate: Cast iron or fabricated steel mounted on concrete equipment pad as shown on Drawings.
 2. Support Stand: Designed by manufacturer and reinforced to withstand anticipated loadings of blower, motor, inlet and discharge silencers, and associated piping.
 3. Factory mount blower and motor as a package.
 4. Provide vibration isolators to limit transmission of vibration to anchor points at floor.

2.3 ACCESSORIES

- A. Air Inlet Filter and Silencer:
1. Provide individual filter for each blower.
 2. Provide 98 percent removal efficiency on 10-micron and above.
 3. Filter shall be mounted internal to sound enclosure.
 4. Designed to reduce pulsation from rotary lobe blowers at blower operating timing gear speed.
 5. For timing gear speeds below transition speeds, use a multi-chambered reactive type silencer, and for timing gear speeds at or above transition speed, use a multi-chambered reactive and absorptive type silencer packed with hair-felt packing.
 6. Inlet/Outlet Air Velocity: 5,500 feet per minute, maximum.
 7. Pressure Loss: 6 inches of WC maximum, through silencer at design flow rate.
 8. Inlet and outlet flanges shall match the piping size shown on Drawings and blower flanges.
 9. Flange Drilling: 125-pound ANSI standard.
 10. Provide drain coupling and plug.
 11. Mount inlet and discharge silencers internal to the blower sound enclosure.
 12. Manufacturers and Products:
 - a. Endustra.
 - b. Universal.
 - c. Stoddard.
- B. Blowoff Silencer:
1. Designed to reduce pulsation from rotary lobe blowers at blower operating timing gear speed.
 2. For timing gear speeds below transition speeds, use a multi-chambered reactive type silencer, and for timing gear speeds at or above transition speed, use a multi-chambered reactive and absorptive type silencer packed with hair-felt packing.
 3. Inlet/Outlet Air Velocity: 5,500 feet per minute, maximum, sized to blow off the air from one blower specified in this section.
 4. Pressure Loss: 30 inches of WC maximum, through silencer at design flow rate.
 5. Inlet and outlet flanges shall match the piping size shown on Drawings. Flange drilling shall be 125-pound ANSI standard. Silencer shall be a straight through design as shown on Drawings.

6. Provide drain coupling and plug.
 7. Ship loose for field mounting in the blow off piping by installing subcontractor. Blow off valve provided by others and not part of the blower manufacturer scope of supply.
- C. Flexible Connectors:
1. Pressure spool, single arch, expansion joint type with 125-pound ANSI flanges, sized to match blower flanges.
 2. Operating Temperature Rating: 250 degrees F.
 3. Install on each blower at outlet flange.
 4. Thrust restraint rods on discharge if not otherwise restrained.
 5. Manufacturers and Products:
 - a. Mercer; Style 500.
 - b. General Rubber; Style 101.
- D. Check Valve:
1. Dual-plate, metal hinged wafer type for each blower; installed in blower discharge piping downstream of silencer and relief valve.
 2. Cast iron body, stainless steel pin and spring, and two semicircular bronze or stainless steel plates.
 3. Seat: Viton or Silicone for high temperature operation.
 4. Elastomeric hinges will not be allowed.
 5. Manufacturer and Product: Cameron; TECHNO, "or-equal."
- E. Safety Relief Valve:
1. Per manufacturer standard.
 2. Sized to relieve entire discharge flow without overloading blower.
 3. Furnish one for each blower.
 4. Provide relief valve on discharge connection mounted inside the blower enclosure.
- F. Noise Enclosure:
1. Total Noise Enclosure: 85 dBA average noise level at 1 meter.
 2. Removable panels to access filter and belt drive areas of the blower for routine maintenance.
 3. Enclosure Cooling: Fan-cooled by fan mounted on blower or motor drive shaft and driven by blower drive motor, or 120-volt or 460-volt electric motor operated fans powered from a separate 120V circuit or from the main motor 460V circuit.
- G. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.
- H. Equipment Identification Plates: Provide 16-gauge stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 3/8-inch-high die-stamped block type equipment identification number indicated in this specification.
- I. Anchor Bolts: Refer to [Section 01 88 15](#).

2.4 INSTRUMENTATION

- A. System Status Monitoring Devices:
 - 1. Inlet filter High differential pressure switch or inlet pressure LOW pressure switch.
 - 2. Discharge High Temperature Switch: 100-degree to 350-degree range, NEMA 4.
 - 3. Discharge High Pressure Switch: 5 psig to 15 psig range, NEMA 4.
 - 4. Discharge Pressure Gauge: Liquid filled, 4.5-inch face, as manufactured by Ashcroft.
 - 5. Inlet and Discharge Temperature Gauges: Minus 20 degrees F to 120 degrees F inlet, 50 degrees F to 400 degrees F discharge, 5-inch- diameter dial every angle, as manufactured by Ashcroft.
 - 6. Inlet filter differential pressure gauge.
 - 7. Switches to have form-C contacts rated for 3 amps at 120V.
- B. Shop/Factory Finishing: Prepare, prime, and finish coat in accordance with manufacturer's standard coating system.

2.5 SOURCE QUALITY CONTROL

- A. Blower Performance Test:
 - 1. Perform on the blower actually furnished in accordance with manufacturer's established criteria.
 - 2. Test each blower for a minimum of 1 hour after stabilization at conditions near the performance ratings for mechanical integrity and flow performance.
 - a. Perform at or above specified performance pressure rise.
 - b. Tolerance on Flow: Plus or minus 4 percent, after correction to rated conditions.
 - 3. Measure motor amperage.
 - 4. Test Report: Confirm capacity and power, complete with data and calculations used in the test.
- B. Motor Test:
 - 1. See **Section 26 20 00**.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. In accordance with manufacturer's written instructions.
- B. Install one check valve in the blower discharge piping, downstream of the silencer and safety relief valve.
- C. Install blower package on vibration isolators and anchor bolts in strict accordance with manufacturer's written instructions.

3.2 FIELD TESTING

- A. In accordance with Section 01 81 00.
- B. Component Testing:
 - 1. Perform Component Testing in accordance with Section 01 81 00.

2. Component testing shall consist of basic equipment inspection and testing completed under both “dry” and “wet” conditions to establish proper connectivity, functionality, and operability, with a goal of confirming readiness to move to Systems Testing in “wet” conditions.
 3. Functional Test: Prior to Systems Testing, conduct on each Blower System for correct rotation, proper alignment and connection, quiet operation, and specified performance.
 - a. Includes testing of all control functionality:
 - 1) Local – Manual.
 - 2) All equipment controls, hard-wired interlocks.
 - 3) All External Interfaces:
 - a) All equipment status and monitoring points to/from the equipment.
 - b) All alarms to/from the equipment.
 - c) All setpoints to/from other systems.
 - b. SCADA testing shall be conducted with all network connections to equipment completed, fully terminated, and successfully communicating to other systems, unless otherwise approved by the Design-Builder.
- C. Systems Testing:
1. Perform Systems Testing in accordance with Section 01 81 00.
 2. During systems testing, individual process units and systems shall be independently tested and evaluated in a wet environment (i.e., in an environment similar to normal operating conditions) to confirm basic functionality and that the controls are performing as designed.
 3. Includes testing of all control functionality:
 - a. All control, monitoring, alarm, and network functions:
 - 1) All interlocks.
 - 2) All status, monitoring, alarms, and control functions.
 - 3) All status and control functions via network connections.
 - b. Remote Controls:
 - 1) Remote Manual.
 - 2) Remote Automatic.

3.3 MANUFACTURER'S SERVICES

- A. Provide manufacturer's services necessary to provide a Manufacturer's Certificate of Proper Installation per Section 01 43 33.
- B. Provide training to operations and maintenance personnel per Section 01 43 33.

END OF SECTION

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SECTION 44 42 56.05
SUBMERSIBLE SUMP PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Simplex Sump Pump Systems:
 - 1. 55PUMP06401: Truck Unloading Containment Pump.
- B. Duplex Sump Pump Systems:
 - 1. 45PUMP06101 and 45PUMP06102, 45CP06101; Filter Gallery Sump Pumps 1 and 2.
 - 2. 75PUMP15801 and 75PUMP15802, 75CP15801; Finished Water Pump Station Sump Pumps 1 and 2.

1.2 REFERENCED SECTIONS

- A. The following Sections are referenced in this Section:
 - 1. Section 01 43 33, Manufacturers' Field Services
 - 2. Section 01 78 23, Operation and Maintenance Data
 - 3. Section 01 81 00, Equipment and Facility Commissioning
 - 4. Section 09 90 00, Painting and Coating
 - 5. Section 26 20 00, Low-Voltage AC Induction Motors.
 - 6. Section 40 99 90, Package Control Systems.

1.3 REFERENCES

- A. The following is a list of standards that may be referenced in this section:
 - 1. American Bearing Manufacturers Association (ABMA):
 - a. 9, Load Ratings and Fatigue Life for Ball Bearings.
 - b. 11, Load Rating and Fatigue Life for Roller Bearings.
 - 2. American Society of Mechanical Engineers (ASME): B16.1, Gray Iron Pipe Flanges and Flanged Fittings, Class 25, 125, and 150.
 - 3. ASTM International (ASTM):
 - a. A48, Standard Specification for Gray Iron Castings.
 - b. A576, Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.
 - 4. Hydraulic Institute Standards (HIS):
 - a. 11.6, Submersible Pump Test.
 - b. 14.6, Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.
 - 5. National Electrical Manufacturers Association (NEMA).
 - 6. UL.

1.4 DEFINITIONS

- A. Terminology pertaining to pumping unit performance and construction shall conform to ratings and nomenclature of Hydraulic Institute Standards.

1.5 SUBMITTALS

A. Action Submittals:

1. Make, model, weight, and horsepower of each equipment assembly.
2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction, including cable seal details.
3. Performance data curves showing head, capacity, horsepower demand, and pump efficiency over entire operating range of pump, from shutoff to maximum capacity. Indicate separately head, capacity, horsepower demand, overall efficiency, and minimum submergence required at guarantee point.
4. Submersible motor data, in accordance with the requirements of **Section 26 20 00**.
5. Control Panels: In accordance with **Section 40 99 90**.
 - a. Power and control wiring diagrams, showing panel terminations and terminal numbers.
 - b. Panel layout drawings.
 - c. Control and instrumentation component data, including float switch material.
6. Heat load calculations for panels, including air conditioner sizing calculations where required.
7. Factory-finish system.

B. Informational Submittals:

1. Special shipping, storage and protection, and handling instructions.
2. Manufacturer's printed installation instructions.
3. Factory and Field Performance Test Reports where factory testing is specified for pumps.
4. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
5. Operation and Maintenance Data: As specified in **Section 01 78 23**.
6. Manufacturer's Certificate of Proper Installation: **See Section 01 43 33**.

1.6 EXTRA MATERIALS

A. Furnish one set for each specific model of pump provided:

1. One complete set of special tools required to dismantle pump.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Submersible, vertical shaft, centrifugal nonclog type, for pumping wastewater.
- B. Designed for continuous operation under submerged or partially submerged conditions, and intermittent operation when totally dry without damage to pump or motor.
- C. Pump and Electrical Driver: No locations are electrically classified areas.
- D. Pumps and control panels furnished under this section to be provided by a single manufacturer.

2.2 SUPPLEMENTS

- A. Specific requirements are attached to this section as supplements.

2.3 COMPONENTS

- A. Equipment consists of pump complete with submersible motor, power cable, float switch(es), control panel, and pump lifting cable.
- B. Characteristics:
 - 1. Motor and rotating parts shall be removable from motor end of pump.
 - 2. Mating surfaces to be watertight and fitted with nitrile O-rings.
 - 3. Pumps fitted with dynamically balanced nonclog impellers designed to pass coarse solids and stringy materials.
- C. Lifting Arrangement:
 - 1. Type 316 stainless steel chain, 20 feet, and one Type 316 stainless steel "grip-eye."
 - 2. Attach chain permanently to pump and access platform with Type 316 stainless steel wire rope.
 - 3. "Grip-eye" capable of being threaded over and engaging links of stainless steel chain so pump and motor may be lifted with "grip-eye" and independent hoist.
- D. Oil chamber between seals shall be equipped with drain and inspection plug. Plug shall have positive antileak seal and shall be easily accessible from outside.
- E. Motor nameplate horsepower not to be exceeded at any head-capacity point on pump curve with a 0.6 hp motor. Motor speed 3,600 rpm (maximum).
- F. Motor Voltage: 120V ac, single-phase, 60-Hz.
- G. Pump motor and sensor cables shall be suitable for submersible pump application and cable sizing shall conform to NFPA 70 specifications for pump motors. Cables shall be of sufficient length to reach control panel or junction box without strain or splicing.
- H. Cable Entry System:
 - 1. Junction chamber and motor separated by stator lead sealing gland or terminal board that prevents foreign material entering through pump top.
 - 2. Utilize cable with factory-installed sealing gland with nonshrink epoxy seal system.
 - 3. O-ring compression seal between sealing gland and cable entry point shall also be acceptable.

2.4 CONTROL PANEL

- A. Provide package control panel for each sump pump system. Panel and components meeting requirements of Section 40 99 90.
- B. Enclosure: In accordance with Section 40 99 90 and per the Material Classification Sheet in the General Section on Drawings.
- C. Simplex Pump System Control Panel:
 - 1. Power: 120V ac, 60-Hz. Main circuit breaker disconnect, pad-lockable, interlocked with panel door.
 - 2. Combination circuit breaker type NEMA-rated motor starter.
 - 3. START and STOP pushbutton switches.
 - 4. HIGH level alarm LED pilot light or beacon.

5. Function:
 - a. Simplex pump systems are located in chemical containment areas and are intended for manual start operation only, with LOW level stop. Pump shall not start automatically.
 - b. START and STOP pushbuttons for manual operation.
 - c. LOW level switch stops pump automatically.
 - d. HIGH level switch generates alarm.
 6. External Interfaces:
 - a. Provide auxiliary contacts and relays to generate dry contacts for signal to plant control system. Contacts rated 5A at 120V ac:
 - 1) Pump RUNNING.
 - 2) HIGH level alarm.
- D. Duplex Pump System Control Panel:
1. Power: 120V ac, 60-Hz. Main circuit breaker disconnect, pad-lockable, interlocked with panel door.
 2. Combination circuit breaker type NEMA-rated motor starter for each pump.
 3. ON/OFF/REMOTE selector switch for each pump.
 4. START and STOP pushbutton switches for each pump.
 5. 1/ALT/2 selector switch for lead pump selection.
 6. HIGH-HIGH level alarm LED pilot light or beacon.
 7. Function:
 - a. Duplex pump systems are located in process areas with drains and hose-down, and are intended for fully automatic operation in a Lead-Lag configuration.
 - b. ON/OFF/REMOTE Selection: When in ON, the START and STOP pushbuttons provide manual operation. When in OFF, the pump does not run. When in REMOTE, the pump is controlled by sump level switches.
 - c. 1/ALT/2 Selection: When set to 1, Pump No. 1 always runs as Lead pump. When set to 2, Pump No. 2 always runs as Lead pump. When set to ALT, the Lead pump alternates every time the pump stops. Provide alternating relay to control automatic pump alternation.
 - d. LOW level switch stops pump automatically in both ON and REMOTE.
 - e. HIGH level switch starts the Lead pump in REMOTE.
 - f. HIGH-HIGH level switch starts the Lag pump in REMOTE and generates alarm.
 8. External Interfaces:
 - a. Provide auxiliary contacts and relays to generate dry contacts for signal to plant control system. Contacts rated 5A at 120V ac:
 - 1) Pump 1 RUNNING.
 - 2) Pump 2 RUNNING.
 - 3) HIGH-HIGH level alarm.

2.5 ACCESSORIES

A. Level Switches:

1. Include the following level switches with the local control panel for each packaged submersible pump system:
 - a. Simplex Pump System:
 - 1) LOW Level: Stop Pump.
 - 2) HIGH Level: Alarm Only (no automatic start).
 - b. Duplex Pump System:
 - 1) LOW Level: Stop Pumps.
 - 2) HIGH Level: Start Lead Pump.
 - 3) HIGH-HIGH Level: Start Lag Pump and Alarm.
2. Type: Totally enclosed, watertight assembly with integral cable. Heavy-duty chemical-resistant cable and float material.
3. Service: Chemical spill wash down and general wash down. Select material based on the chemical system served. See Drawings.
4. Switch Contacts: 120V ac, mercury-free, suitable for the motor starters provided with the pumps.

- B. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in readily visible location.

2.6 FACTORY FINISHING

- A. System No. 1 for the submerged pump, System No. 4 for outdoor control panels and System No. 5 for indoor control panels, as specified in Section 09 90 00, Painting and Coating.

2.7 SOURCE QUALITY CONTROL

A. Pump:

1. Factory Functional Test: Provide Manufacturer's standard functional test.

- B. Submersible Motor Functional Test: In accordance with HIS 11.6.

- C. Control Panel: For each panel furnished. Inspect for proper construction and wire termination. Test for intended function.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions.
- B. Connect piping without imposing strain to nozzles.

3.2 FIELD FINISHING

- A. Touch up any damaged coatings with paint provided by or approved by the manufacturer.

3.3 FIELD TESTING

- A. In accordance with Section 01 81 00.

B. Component Testing:

1. Perform Component Testing: In accordance with Section 01 81 00.

2. Component Equipment Testing shall consist of basic equipment inspection and testing completed under both “dry” and “wet” conditions to establish proper connectivity, functionality, and operability, with a goal of confirming readiness to move to Systems Testing in “wet” conditions.
3. Functional Test: Prior to Systems Testing, conduct on each Blower System, assisted by manufacturer’s representative, for correct rotation, proper alignment and connection, quiet operation, and specified performance.
 - a. Includes testing of all control functionality:
 - 1) Local – Manual.
 - 2) All equipment controls, hard-wired interlocks.
 - 3) All External Interfaces:
 - a) All equipment status and monitoring points to/from the equipment.
 - b) All alarms to/from the equipment.
 - c) All setpoints to/from other systems.
 - b. SCADA testing shall be conducted with all network connections to equipment completed, fully terminated, and successfully communicating to other systems, unless otherwise approved by the Design-Builder.
 - c. Flow Output:
 - 1) Measure by plant instrumentation and storage volumes.
 - 2) Test for continuous 2-hour period pumping clean water.
 - 3) Test Report Requirements: In accordance with Hydraulic Institute Standards for submersible pump tests HIS 14.6 and HIS 11.6.

C. Systems Testing:

1. Perform Systems Testing: In accordance with Section 01 81 00.
2. During systems testing, individual process units and systems shall be independently tested and evaluated in a wet environment (i.e., in an environment similar to normal operating conditions) to confirm basic functionality and that the controls are performing as designed.
3. Includes testing of all control functionality:
 - a. All control, monitoring, alarm, and network functions:
 - 1) All interlocks.
 - 2) All status, monitoring, alarms, and control functions.
 - 3) All status and control functions via network connections.
 - b. Remote Controls:
 - 1) Remote Manual.
 - 2) Remote Automatic.

3.4 SUPPLEMENT

- A. The supplement listed below, following “End of Section,” is part of this Specification:
 1. Sump Pump Data Sheet.

END OF SECTION

SUMP PUMP DATA SHEET

Pump Names and Tag Numbers: As Noted under Section Equipment and Component Number

Manufacturer and Model Number: (1) Xylem (Ready 4 MT 1~ 2p)
(2) Goulds 2DW

SERVICE CONDITIONS

Liquid Pumped (Material and Percent Solids): Flushing/Drainage/Cleaning Water with up to 2% solids.

Fluid Temperature (Fahrenheit): Normal: 68 Max 90 Min 32

Specific Gravity at 60 Degrees F 1 Viscosity Range Std for water

Vapor Pressure at 60 Degrees 0.2563 psi pH: 6.5 to 8.5

Abrasive (Y/N) N Possible Scale Buildup (Y/N): N

Minimum diameter solid pump can pass (inches): 1/2

Min. NPSH Available (Ft. Absolute): 32

PERFORMANCE REQUIREMENTS

Capacity (US gpm): Rated 25

Total Dynamic Head (Ft): Rated 25

Maximum Shutoff Pressure (Ft): 35

Min. Rated Pump Hydraulic Efficiency at Rated Capacity (%): 71.7

Max. Pump Speed at Rated Capacity (rpm): 3,600

Constant (Y/N): Y Adjustable (Y/N): N

DESIGN AND MATERIALS

Pump Type: Submersible Sump Pump

Volute Material: Cast Iron ASTM A48

Pump Casing Material: Cast Iron ASTM A48

Motor Housing Material: Cast Iron ASTM A48

Wear Rings Case (Y/N): Y, if available Material: Hardened stainless steel

Wear Ring Impeller (Y/N): N Material:

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SECTION 44 42 56.17
SAMPLING PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Furnished and installed complete, tested and operating filter effluent sample pump P3001 as shown on Contract Drawings.

1.2 REFERENCED SECTIONS

- A. The following Sections are referenced in this Sections:

1. Section 01 43 33, Manufacturers' Field Services
2. Section 01 78 23, Operation and Maintenance Data
3. Section 01 81 00, Equipment and System Testing, Startup and Demonstration
4. Section 01 88 15, Anchorage and Bracing
5. Section 03 60 00, Grouts
6. Section 05 50 00, Metal Fabrications.
7. Section 09 90 00, Painting and Coating.
8. Section 26 20 00, Low-Voltage AC Induction Motors.

1.3 REFERENCES

1. The following is a list of standards which may be referenced in this Section:
2. American Bearing Manufacturers' Association (ABMA).
3. Hydraulic Institute Standards (HIS).
4. National Electrical Manufacturer's Association (NEMA): MG 1, Motors and Generators.
5. UL.

1.4 SUBMITTALS

- A. Action Submittals:

1. Shop Drawings:
 - a. Make, model, weight, and horsepower of each equipment assembly.
 - b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
 - c. Performance data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity.
 - d. Detailed mechanical, and electrical drawings showing the equipment dimensions, size, and locations of connections and weights of associated equipment.
 - e. Power and control wiring diagrams, including terminals and numbers.
 - f. Complete motor nameplate data, in accordance with Section 26 20 00.
 - g. Factory finish system.

- h. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15.

B. Informational Submittals:

- 1. NSF certification(s) verifying products meet the requirements specified herein.
- 2. Seismic anchorage and bracing calculations as required by Section 01 88 15.
- 3. Factory Performance Test Report.
- 4. Special shipping, storage and protection, and handling instructions.
- 5. Manufacturer's printed installation instructions.
- 6. Operation and Maintenance Data: As specified in Section 01 78 23.
- 7. Manufacturer's Certificate of Proper Installation, comply with Section 01 43 33.

1.5 EXTRA MATERIALS

- A. Furnish one shelf spare pump.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Coordinate sample pump installation with adjoining piping and analytical instrumentation as required for a complete water quality sampling system.
- B. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
 - 1. Use or reuse of components and materials without a traceable certification is prohibited.

2.2 SAMPLE PUMP TYPES

- A. Type 1 - Inline Vertical Multistage Centrifugal Sample Pump:
 - 1. For pumping applications that require low flow, low to medium head, flooded suction, and corrosion resistance.
 - 2. Description: Vertical multistage, nonself-priming, continuous duty rated.
 - 3. Process Connections: 1-inch NPT or flanged.
 - 4. Pump Operating Conditions:
 - a. Capacity: As indicated in the Sample Pump Schedule.
 - b. Maximum Total Dynamic Head: As indicated in the Sample Pump Schedule.
 - c. Fluid Temperature Range: 45 degrees F to 90 degrees F.
 - 5. Materials of Construction:
 - a. Pump Body: AISI Type 304 stainless steel.
 - b. Impeller: AISI Type 304 stainless steel.
 - c. Shaft: AISI Type 431 stainless steel.

- d. Internal Flush Mechanical Seal: Viton or Teflon (PTFE) with Type 316 stainless steel faces.
- 6. Motor:
 - a. Totally enclosed fan cooled (TEFC), rated for 50 degrees C, close coupled to pump in accordance with Section 26 20 00.
 - b. Low-Voltage AC Induction Motors.
 - c. 460-volt, three-phase, 60-Hz.
 - d. Size as indicated on the Sample Pump Schedule.
- 7. Manufacturer and Product: Grundfos CR1 Series, "or-equal."

2.3 ACCESSORIES

- A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.
- B. Lifting Lugs: Equipment weighing over 100 pounds.
- C. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, 1/2-inch minimum diameter, and as specified in Section 05 50 00.

2.4 MANUFACTURER'S STANDARD. SOURCE QUALITY CONTROL

- A. Factory Tests and Adjustments: Test equipment actually furnished.
- B. Factory Test Report: Include curve test results.
- C. Functional Test: Perform manufacturer's standard test on equipment.
- D. Motor Test: See Section 26 20 00.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions.
- B. Level base by means of steel wedges (steel plates and steel shims). Wedge taper not greater than 1/4 inch per foot. Use double wedges to provide a level bearing surface for pump and driver base. Accomplish wedging so there is no change of level or springing of baseplate when anchor bolts are tightened.
- C. Adjust pump assemblies such that the driving units are properly aligned, plumb, and level with the driven units and all interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.
- D. After pump and driver have been set in position, aligned, and shimmed to proper elevation, grout space between bottom of baseplate and concrete foundation with poured, nonshrinking grout of proper category, as specified in Section 03 60 00. Remove wedges after grout is set and pack void with grout.
- E. Connect suction and discharge piping without imposing strain to pump flanges.
- F. Anchor Bolts: Accurately place using equipment templates and as specified in Section 05 50 00.

3.2 FIELD FINISHING

- A. Equipment as specified in Section 09 90 00.

3.3 FIELD TESTING

- A. In accordance with Section 01 81 00.
- B. Component Testing:
 - 1. Perform Component Testing in accordance with Section 01 81 00.
 - 2. Component Equipment Testing shall consist of basic equipment inspection and testing completed under both “dry” and “wet” conditions to establish proper connectivity, functionality, and operability, with a goal of confirming readiness to move to Systems Testing in “wet” conditions.
 - 3. Functional Tests:
 - 4. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
 - 5. Performance Test: In accordance with Hydraulic Institute Standards.

3.4 MANUFACTURER'S SERVICES

- A. Manufacturer's Representative:
 - 1. Present at Site the following:
 - a. Performance testing and completion of Manufacturer's Certificate of Proper Installation.
 - b. Prestartup training. See Section 01 43 33 and Section 01 81 00.

3.5 SUPPLEMENT

- A. The supplement listed below, following “End of Section,” is a part of this Specification.
 - 1. Sample Pump Schedule.

END OF SECTION

**REGIONAL SURFACE WATER SUPPLY
MAIN PLANT**

SAMPLE PUMP SCHEDULE							
Tag #	Description	Rated Capacity (US gpm)	Rated Differential Pressure (ft)	Range (US gpm)	Max Pump Speed (rpm)	Constant or Adjustable Speed	Speed Range (% of Rated)
P3001	Filter Effluent Sample Pump 1	2.5	60	0 – 5	3,600	Constant	--

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SECTION 46 05 13
GENERAL REQUIREMENTS FOR EQUIPMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. General requirements applicable to mechanical equipment and systems.
- B. Ensure mechanical equipment meets the requirements of this Section in addition to the specific requirements of the individual equipment specification Sections.

1.02 REFERENCED SECTIONS

- A. The following Sections are referenced in this Section
 - 1. Section 01 61 11 – Seismic Anchorage and Bracing
 - 2. Section 01 78 23 – Operation and Maintenance Data
 - 3. Section 01 81 00 – Equipment and System Testing, Startup and Demonstration
 - 4. Section 01 99 90 – Reference Forms
 - 5. Section 09 96 00 – High Performance Coatings

1.03 GENERAL REQUIREMENTS

- A. Equipment shall be of new construction and comply with the following requirements:
 - 1. Designed for stresses that may occur during fabrication, transportation, erection, and during continuous or intermittent operations.
 - 2. Adequately anchored, leveled, aligned, and ready for operation without binding or overloading of critical components or motors.
 - 3. Installed with necessary appurtenances required for proper operation and installation in a neat and workmanlike manner.
 - 4. Tested by factory trained service mechanics or engineers.

1.04 UNIT RESPONSIBILITY

- A. Equipment systems shall be assembled as a unit by a single manufacturer responsible for the entire unit.
 - 1. Responsibility extends to selecting components of the system to assure compatibility, proper operation, and compliance with specified performance requirements.
 - 2. Unit responsibility does not relieve Contractor of responsibility to Owner for performance of the Work.

1.05 QUALITY ASSURANCE

- A. Arrangement
 - 1. The arrangement of equipment shown on the Drawings is based upon information available at the time of design and is not intended to show exact dimensions peculiar to a specific manufacturer.
 - 2. Some features of the illustrated equipment installation may require revision to meet actual equipment installation requirements.

3. Structural supports, foundations, connected piping, and valves shown may have to be altered to accommodate the equipment provided. Additional payment will not be made for such revisions and alterations.

1.06 SUBMITTALS

- A. General: Provide separate submittals for each equipment item or group of related equipment items.
- B. Equipment Anchorage: Submit anchor bolt sizing calculations.
- C. Bearing Life Calculations: Submit bearing L-10 life calculations in accordance with ABMA requirements.

1.07 OPERATION AND MAINTENANCE MANUALS

- A. Furnish operation and maintenance manuals for each equipment system in accordance with the Section 01 78 23 requirements.

1.08 PROTECTION DURING SHIPMENT

- A. Shipping: Ship equipment in sealed, weather-tight, enclosed conveyances, and protected against damaging stresses during transport and handling.
- B. Bearing Housings: Wrap or otherwise seal to prevent contamination by grit and dirt, and tape closed ventilation and other types of openings.
- C. Repair any damaged materials to conform to the requirements of the Contract before the assembly is incorporated into the Work. The Contractor shall bear the costs arising out of dismantling, inspection, repair, and reassembly.

PART 2 - PRODUCTS

2.01 PIPING CONNECTIONS ON EQUIPMENT

- A. Flanges on Equipment: Conform to dimensions and drilling specified in ANSI B16.1, Class 125 unless otherwise required by Division 40 pipe specifications or the Drawings.
- B. Pipe Flanges: Conform to dimensions and drilling specified in AWWA C207, Class D, 125 lb flanges provided on connection pipe.
- C. Threaded Flanges: Flat faced with standard taper pipe thread conforming to ANSI B1.20.1.
- D. Pipe Threads: Conform in dimension and limits of size to ANSI B1.1, coarse thread series, Class 2 fit.
- E. Flange Assembly Bolts and Nuts
 1. Heavy pattern, hexagonal head, stainless steel machine bolts with heavy pattern, hot pressed, hexagonal nuts conforming to ANSI B18.2.1 and B18.2.2.
 2. Threads: Unified Screw Threads, Standard Coarse Thread Series, Class 2A and 2B, ANSI B1.1.

2.02 BEARINGS

- A. Service: Unless otherwise specified, equipment bearings shall be oil or grease lubricated, ball or roller type, designed to withstand the stresses of the service specified.
- B. Rating
 1. L-10 Rating Life: Minimum 50,000 hours unless otherwise specified. Determine rating life using the maximum equipment operating speed.

2. Determine rating in accordance with the latest revisions of AFBMA Methods of Evaluating Load Ratings of Ball and Roller Bearings.
 3. Where individual equipment Sections specify higher bearing life ratings, those requirements supersede the minimum bearing life specified above.
- C. Grease Lubricated Bearings
1. Fit with easily accessible grease supply, flush, drain and relief fittings, except those bearings specified to be factory sealed and lubricated.
 2. Extend non-accessible grease fittings to an easily accessible location using 1/4-inch diameter stainless steel tubing as an extension tube.
 3. Grease supply fittings: Standard hydraulic Alemite or Zerk type.
- D. Oil Lubricated Bearings
1. Equip with either a pressure lubricating system or a separate oil reservoir type system.
 2. Size oil lubrication systems to safely absorb the heat energy normally generated in the bearing under a maximum ambient temperature of 60°C.
 3. Equip with a filler pipe and an external level indicator gage.
- E. Incorporate bearing housings with sufficient cooling to maintain surface temperature at 65 degrees C or less for continuous operation at bearing rated load and a 50 degrees C ambient temperature, or install appropriate shielding on bearings that are accessible to touch.

2.03 DRIVE COMPONENTS

- A. V-Belt Drives
1. Design with sliding base or other suitable tension adjustment.
 2. Design with service factor of at least 1.6 at maximum speed.
 3. Statically balance sheaves. In addition, dynamically balance sheaves that will operate at peripheral speed of more than 5,500 feet per minute.
 4. Belts: Provide anti-static belts when explosion-proof equipment or environment is specified.
- B. Gear Reducers
1. Provide drives with nominal input horsepower rating equal to or greater than the nameplate horsepower of the drive motor.
 2. Provide gear drives manufactured in accordance with AGMA Class II service requirements.

2.04 SHAFT COUPLINGS

- A. Type and Rating: Non-lubricated, designed for a minimum of 50,000 hours operating life.
- B. Equipment with a driver greater than 1/2 horsepower, and where the input shaft of a driven unit is directly connected to the output shaft of the driver, shall have its two shafts connected by a flexible coupling which can accommodate angular misalignment, parallel misalignment and end float, and which cushions shock loads and dampens torsional vibrations.
- C. Provide couplings recommended by the coupling manufacturer for the specific application, considering horsepower, speed of rotation, and type of service.

- D. Install couplings in conformance to the manufacturer's instructions.

2.05 GUARDS

A. Guards

- 1. Enclose exposed moving parts with guards that meet the requirements of federal and state OSHA requirements.

B. Materials

- 1. Fabricate guards of 14 gauge steel and expanded metal screen to provide visual inspection of moving parts without removal of the guard.
- 2. Galvanize after fabrication and paint with the equipment.
- 3. Fasteners: Type 304 stainless steel.

2.06 NAMEPLATES AND LIFTING EYES

A. Nameplates

- 1. Provide on each item of equipment with the specified equipment name or abbreviation and equipment number.
- 2. Engrave or stamp (not painted) on stainless steel and fastened to the equipment in an accessible location with stainless steel screws or drive pins.

B. Lifting Eyes

- 1. Provide on equipment weighing over 80 lbs.

2.07 SPARE PARTS AND LUBRICANTS

A. Spare Parts: Provide for each item of mechanical, electrical, and instrumentation equipment a supply of spare parts and special tools required for the starting, testing, adjustments, and initial operation. Pack spare parts required by individual equipment specifications:

- 1. Pack spare parts with individual weights less than 50 pounds in a heavily constructed painted wood box with hinged cover and a locking clasp.
- 2. Provide a typed inventory of spare parts stapled to the underside of the cover.
- 3. Tag and wrap each part in a waterproof container. Spare bearings shall be encapsulated in an airtight plastic film.

B. Lubricants: Provide for each item of mechanical equipment of the type recommended by the equipment manufacturer a supply of the lubricant for startup, testing, and initial operation.

- 1. Provide a list showing the required lubricants for each item of mechanical equipment. List estimated quantity of lubricant needed for a full year's operation, assuming the equipment will operate continuously.
- 2. Lubricants shall be products of the Owner's current lubricant supplier.
- 3. Limit the various types of lubricants by consolidating them, with the equipment manufacturer's approval, into the least number of different types.

2.08 ANCHOR BOLTS

A. Size anchor bolts and concrete anchors for equipment in accordance with Section 01 61 11.

2.09 FACTORY APPLIED COATINGS

- A. Ship each item of equipment to the site of the work with a shop applied prime coating prepared in accordance with the requirements of Section 09 96 00 and compatible with the finish coatings.
- B. Finish Painting of Motors: Factory-apply finish coats using manufacturer's standard coating, unless otherwise specified in Section 09 96 00.

2.10 SPECIAL TOOLS AND ACCESSORIES

- A. Furnish with each piece of equipment all tools, instruments, or accessories of a special nature that are required to assemble, disassemble, maintain, or repair any item of equipment.
 - 1. Tag and mark each piece indicating their service and the piece of equipment for which their use is intended.
 - 2. Include a list and description or pictorial representation of all special tools required for a given piece of equipment for insertion into the equipment operation and maintenance manual.

2.11 FASTENERS AND DIELECTRIC ISOLATION

- A. Fasteners for Aluminum: Stainless steel.
- B. Isolate steel surfaces, other than stainless steel, from aluminum with stainless steel, neoprene, non-metallic washers or other acceptable material.
- C. Dissimilar Metals: Protect from galvanic corrosion by means of pressure tapes, coatings, or isolators.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install, align, and test each item of equipment within the tolerances recommended by the equipment manufacturer.
- B. When specified in individual Sections, install and test equipment under the direction of installation engineers who have been factory trained by the equipment manufacturer.
- C. Perform all work in accordance with manufacturer's recommendations.

3.02 QUALITY CONTROL

- A. Test equipment in accordance with Section 01 81 00 and the individual equipment Section.
- B. Furnish written certification from the equipment manufacturers that each item has been installed, aligned, and tested correctly and that the installation meets the manufacturer's requirements for efficient, trouble-free operation. Utilize Manufacturer's Installation Certification Form provided in Section 01 99 90.
- C. Equipment manufacturer's certification shall not be construed as relieving the Contractor of his overall responsibility for this portion of the work.

END OF SECTION

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SECTION 46 05 14
EQUIPMENT MOUNTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Equipment mounting requirements, including fabricated steel equipment bases, concrete equipment pads, supports, anchorage, and accessories.

1.2 REFERENCED SECTIONS

- A. The following Sections are referenced in this Section
 - 1. Section 05 50 01 – Anchor Bolts and Anchoring Devices
 - 2. Section 09 96 00 – High Performance Coatings

1.3 QUALITY ASSURANCE

- A. Provide supports, anchorage, and equipment mounts that are sized and designed to resist the calculated forces and that are in accordance with the manufacturer's recommendations, the current International Building Code (IBC), and industry standards requirements.

1.4 DESIGN REQUIREMENTS

- A. Design equipment mounts and anchorages to resist the minimum lateral force required by the latest edition of the IBC, the manufacturer of the equipment, or a lateral seismic force of 60% of the operating weight of the equipment, whichever is greater.
- B. Equipment anchor bolt sizes shown on the Drawings are the minimum required size.
- C. Equipment anchorage design and calculations shall be prepared and signed by a civil or structural engineer currently registered in the state where equipment is installed.

1.5 MOUNTING REQUIREMENTS

- A. Mount equipment and driver on a common fabricated steel baseplate with ample rigidity to support equipment and maintain shaft alignment without excessive deflection.
- B. Mount equipment baseplates on concrete equipment pads.

1.6 SUBMITTALS

- A. Shop Drawings: Provide drawings of equipment bases and anchorage details.
- B. Anchorage Calculations: Submit stamped and signed anchor bolt sizing calculations.

PART 2 - PRODUCTS

2.1 ANCHOR BOLTS AND CONCRETE ANCHORS

- A. Provide anchor bolts and concrete anchors in accordance with Section 05 50 01.

2.2 CONCRETE EQUIPMENT PADS

- A. Construct concrete pedestals at least 6 inches wider and longer than the steel or cast base so that the distance between the anchor bolts and the edge of concrete is at least 3 inches.
- B. Unless otherwise shown or specified, all conduits, piping connections, drains, etc. shall be enclosed by the concrete base.

- C. Shape concrete pedestals to drain away from the base.
- D. Allow concrete to cure 14 days or until the concrete has cured to 75 percent of its specified compressive strength before placing equipment on the concrete pedestal.
- E. Do not start equipment placed on the concrete pedestal until the concrete has cured for 28 days or to 100 percent of its specified compressive strength.

2.3 STRUCTURAL STEEL EQUIPMENT BASES

- A. Provide structural steel bases with thickened steel pads for doweling.
 - 1. Fabricate equipment base using continuous welds to seal seams and contact edges between steel members.
 - 2. Grind welds smooth.
- B. Design equipment bases with perimeter steel beams, intermediate stiffeners and baseplate.
 - 1. Provide perimeter steel beams with minimum depth equal to 1/10th of the longest dimension of the base.
 - 2. Beam depth need not exceed 14 inches provided that the baseplate deflection is kept within acceptable limits to minimize misalignment, as determined by the manufacturer.
- C. Provide grout holes for the bases of equipment where vibration isolation is not specified.
- D. Provide minimum 1-inch thick steel mounting baseplate for equipment with drivers 20 horsepower and larger.
- E. Shop-apply prime coat prepared in accordance with the requirements of **Section 09 96 00** and compatible with the finish coatings

PART 3 - EXECUTION

3.1 GENERAL

- A. Connect piping to equipment with flexible connections and/or expansion joints such that the intended use of these joints is maintained in the piping system.
- B. Coordinate the location of electrical conduit and piping penetrations within the concrete pad and equipment base.
 - 1. Stub-up penetrations on the same side of the equipment as required for connection to the equipment.
 - 2. Locate equipment drains for proper drainage away from equipment.

3.2 EQUIPMENT MOUNTING

- A. Mount equipment on equipment baseplates using stainless steel shims so that equipment and driver are level in both directions and mounted within machined areas on baseplate. Do not use wedges to obtain level and alignment.
- B. Utilize templates for placement of anchor bolts prior to placing concrete for equipment pad.
- C. Apply a non-seize or non-galling compound on the threads of anchor bolts and concrete anchors.

3.3 SHAFT ALIGNMENT

- A. After the complete unit has been installed on the equipment pad and leveled, check the factory shaft alignment by disassembling coupling and measuring angular and parallel orientations.
- B. Use reverse-indicator dial or laser type alignment equipment to align shafts to within the manufacturer's required tolerance. Allow for thermal expansion, spacer coupling length and other factors that affect proper shaft alignment.

3.4 GROUTING EQUIPMENT BASED

- A. After alignment has been completed, tighten anchor bolts and grout between equipment base and equipment pad. Use non-shrink and non-ferrous grout no less than 7/8 inch and no more than 1-5/8-inches thick.
- B. Allow 48 hours for grout to harden and then remove jacking screws. Re-check torque on anchor bolts and re-check shaft alignment, making corrections as necessary.

END OF SECTION

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SECTION 46 30 13
DISINFECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES:

- A. Requirements for disinfection of all inside surfaces with which water may come in contact in the following structures, pipelines, equipment and accessories:
 - 1. Water Storage Facilities:
 - a. Plant Water hydropneumatic tank.
 - 2. Filters, Filtered Water Flume and Tailwater Box
 - 3. Large Pipelines:
 - a. Piping at and between the Filters and existing Treated Water Reservoir.
 - b. Finished water piping.
 - c. Backwash supply piping.
 - d. Filter-to-waste piping.
 - 4. Small Pipelines:
 - a. Hot and cold domestic water piping.
 - b. Fire sprinkler system.
 - c. Plant water.
- B. Dispose of disinfection solution.

1.2 REFERENCED SECTIONS:

- A. Section 01 14 00 – Work Sequence and Constraints

1.3 REFERENCES

- A. American Water Works Association (AWWA):
 - 1. C651 AWWA Standard for Disinfecting Water Mains
 - 2. C652 AWWA Standard for Disinfection of Water Storage Facilities
 - 3. C653 AWWA Standard for Disinfection of Water Treatment Plants

1.4 SCHEDULING

- A. Schedule and coordinate the work with operating personnel. Once disinfection has been satisfactorily accomplished, no further entry to the interior of the facilities will be allowed unless entry must be made to perform repairs, in which case repeat disinfection on a localized basis at no additional cost to the Owner. The Contractor shall be responsible for maintaining security of the disinfected facilities.
- B. Maintain the existing plant in operation, except when shutdowns are allowed per Section 01 14 00.
- C. Disinfect pipelines following successful pressure testing.

1.5 SUBMITTALS

- A. Submit a Disinfection Plan in the Product Review category including the procedures, methods, materials and schedules proposed for disinfecting the required surfaces.

1.6 QUALITY ASSURANCE

- A. Laboratory testing related to disinfection will be performed by and paid for by the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Water: Use treated water from the existing plant.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Provide necessary appurtenances required for the disinfection procedures including taps, temporary piping, connections and shutoff valves. Submit data on appurtenances which will be permanently installed for review by the Engineer.
- B. The Contractor is advised that precautions taken to keep surfaces clean during construction and avoiding the entry of deleterious substances on the work during construction will facilitate achieving the disinfection requirements of this project.
- C. Prior to disinfecting, thoroughly clean accessible surfaces of dust, dirt, foreign matter and deleterious substances remove any oil by contact with absorbents. Use water sprays, steam cleaning, vacuum cleaning, swabbing, hand brushing or a combination of methods and rinsing to effect the cleaning, but do not use any method that will be detrimental to the finish surfaces. Flush inaccessible surfaces clean.

3.2 APPLICATION

- A. After completing construction activities, disinfect the required surfaces with chlorine solutions in accordance with the following procedures. Following disinfection and flushing, the Owner will take water samples for bacteriological analysis of the water. Provide one (1) week of notice to Owner for collecting samples. Samples can be collected Monday through Wednesday only each week. If the specified bacteriological requirements are not satisfied, repeat disinfection procedure until the requirements are met.
- B. Water Storage Facilities:
 - 1. Standard: AWWA C652 as amended herein.
 - 2. Forms of Chlorine: Use sodium hypochlorite or calcium hypochlorite.
 - 3. Method: 2 (Brush or Spray).
- C. Filters (including Filtered Water Flume and Tailwater Box):
 - 1. Standard: AWWA C653 as amended herein.
 - 2. Forms of Chlorine: Sodium hypochlorite or calcium hypochlorite.
 - 3. Method:
 - a. Walls: Method 2 (brush or spray) as discussed in AWWA C652.
 - b. Media: Soak Method.
- D. Large Pipelines:
 - 1. Standard: AWWA C651 as amended herein.
 - 2. Forms of Chlorine: Sodium hypochlorite or calcium hypochlorite
 - 3. Method: Continuous feed.

E. Small Pipelines:

1. Preparation: Provide the system with a 1-inch minimum service cock or valve or other means to inject chlorine solution at a point within 2 or 3 feet of its junction with the supply source. When system is complete, thoroughly flush it by fully opening every outlet until clear water flows from all of them.
2. Disinfecting Agent: Sodium hypochlorite or calcium hypochlorite in sufficient quantities to produce chlorine concentration of at least 50 parts per million in the system.
3. Disinfecting Procedure:
 - a. Connect a hand-operated pump, or other means of injecting the disinfecting agent, to one-inch minimum service cock or valve or other injection device. Pump must provide a pressure greater than that of supply of system.
 - b. With system completely full of water and supply valve open, proceed to adjust every outlet of system so that a trickle of water flows from each.
 - c. Inject disinfectant slowly and continuously at an even rate, not in slugs, until a test at each outlet shows a free chlorine residual concentration of at least 50 parts per million.
 - d. Close all outlets and valves, including valve connecting to supply line and one-inch minimum service cock on solution injection connection. Maintain condition for 24 hours. After 24 hours, test for residual chlorine at each outlet. The free residual chlorine concentration indicated should be not less than 10 ppm. If the indicated free chlorine concentration is less than 10 ppm, repeat disinfection procedure until an approved result is obtained.
 - e. When the above procedure has been completed to the satisfaction of the Engineer, flush out entire system with fresh water until tests at all outlets show a residual of not more than the chlorine residual in the fresh water being used.

3.3 FIELD QUALITY CONTROL

A. Chlorine Residual Testing:

1. AWWA C651, Appendix A, DPD Drop Dilution Method, except where otherwise specified. Testing shall be performed by Contractor.

B. Bacteriological Analyses of Water:

1. After the completion of disinfecting procedure, including the final flushing as described in AWWA C651 and heretofore, the Owner will obtain water samples from this system for bacteriological analyses.
2. Requirements for satisfactory disinfection of water supply are that bacteriological analyses indicate that water samples are negative for coliform organisms, and that Heterotrophic plate count (standard plate count) is less than 100 colony forming units per milliliter.
3. If bacteriological analyses do not satisfy the above requirements, then repeat disinfection procedure until these requirements are met.

3.4 DISPOSAL OF DISINFECTION SOLUTION

- A. Dispose of disinfection solution in the existing Wastewater Reclamation Basin or a new Washwater Recovery Tank or, as a last resort, the existing Sludge Lagoon.

- B. Monitor and report the chlorine concentration in the disposal water and, if necessary for overall project operations, dechlorinate disinfection solution discharges to Basin or Tank.
- C. Coordinate discharge timing with plant operations for capacity availability to avoid unplanned discharges (overflows) to Fagan Creek. Owner will make reasonable attempts to maintain available capacity in the existing Reclamation Basin, new Washwater Recovery Tanks, or existing Sludge Lagoon. Take care to assure that chlorinated water is not spilled into drains or Fagan Creek.

3.5 PROTECTION OF DISINFECTED STRUCTURES

- A. If required to re-enter a disinfected structure, the work shall be conducted utilizing techniques and work methods necessary to maintain the disinfected status. This shall include use of disinfected foot coverings, tools, and the like.
- B. In the event the Contractor contaminates the facilities, effect decontamination at no additional cost to the Owner.

END OF SECTION

SECTION 46 33 42
DIAPHRAGM METERING PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pumps for metering solutions of sodium hypochlorite (hypochlorite) and chemical system accessories. Wetted parts of the sodium hypochlorite pumps shall have National Sanitation Foundation/American National Standards Institute (NSF/ANSI) 61 certification.
- B. Type:
 - 1. Metering pumps shall be motor-driven, positive displacement, disc diaphragm units.
 - 2. Provide metering pumps complete with all piping, valves, accessories, and controls as shown on the Drawings and specified herein supplied loose.
- C. Equipment List:
 - 1. Sodium Hypochlorite Metering Pump 1: PMP-6451
 - 2. Sodium Hypochlorite Metering Pump 2: PMP-6452
 - 3. Sodium Hypochlorite Metering Pump 3: PMP-6453
 - 4. Sodium Hypochlorite Metering Pump 3: PMP-6454

1.2 REFERENCED SECTIONS

- A. The following Sections are referenced in this Section:
 - 1. Section 01 78 23 – Operation and Maintenance Information
 - 2. Section 01820 – Training
 - 3. Section 01 81 00 – Equipment and System Testing
 - 4. Section 01 99 00 – Reference Forms
 - 5. Section 09 96 00 – High-Performance Coatings
 - 6. Section 46 05 13– General Requirements for Equipment
 - 7. Section 46 05 14– Equipment Mounting
 - 8. Section 15119 – Miscellaneous Specialty Valves
 - 9. Section 16220 – Low Voltage Motors

1.3 PERFORMANCE AND DESIGN REQUIREMENTS

- A. Design Requirements:
 - 1. Pumps and appurtenant equipment provided under this section shall be suitable for the following service:
 - a. Chemical pumped: 6.0% - 12.5% sodium hypochlorite
 - b. Maximum solution temperature: 100°F
 - c. Specific gravity (68°F): 1.1-1.2
 - d. pH: 11.0 - 11.4

B. Operating Requirements and Characteristics:

1. Diaphragm type metering pumps provided under this section shall conform to the following:

Equipment No.	Operating Flow, gph		Max. Rated Flow, gph	Maximum Pump Speed, strokes per minute (spm)	Maximum Pump Discharge Pressure, psi
	Min.	Max.			
PMP-6451	3.5	24.5	50	144	150
PMP-6452	3.5	24.5	50	144	150
PMP-6453	3.5	24.5	50	144	150
PMP-6454	3.5	24.5	50	144	150

C. ENVIRONMENTAL CONDITIONS

1. The pumps will be located on concrete pedestals indoors, as shown in the Drawings.

1.4 UNIT RESPONSIBILITY

- A. Assign unit responsibility as specified in Section 46 05 13 to the pump manufacturer for the equipment specified in this section.
- B. A single chemical metering pump manufacturer shall be responsible for supplying all components of the metering pump feed system.
- C. Submit a Certificate of Unit Responsibility (Section 01 99 00).

1.5 SUBMITTALS

- A. Include the following information:
 1. A copy of the contract document control diagrams and process and instrumentation diagrams with addenda updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "No Changes Required." Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
 2. Wiring and connection diagrams indicating all electrical connections.
 3. Piping connections, locations, sizes and details for all fittings.
 4. Proposed on-site testing and start-up procedures.
 5. Catalog information, materials list, and capacity, stroke speed, and discharge pressure data for each pump. Submit NSF 61 certification for wetted parts.
 6. Catalog information for all accessories:
 - a. Pulsation dampeners
 - b. Pressure relief valves
 - c. Isolation valves
 - d. Ball check valves
 - e. Backpressure valve
 - f. Calibration column
 - g. Pressure gauge and isolator

7. Manufacturer's recommended spare parts list.
 8. Equipment mounting submittal information specified in Section 46 05 14.
 9. Documented results of shop-tests for capacity and pressure prior to shipment.
- B. Additional Submittals:
1. Submit operating and maintenance (O&M) information as specified in Section 01 78 23 a minimum of 10 days before equipment shipment.
 2. Completed Manufacturers Installation Certification Form (Section 01 99 00)
 3. Completed Manufacturers Instruction Certification Form (Section 01 99 00)

1.6 WARRANTY

- A. Require the pump manufacturer to warrant the units against defects in materials and workmanship.
1. One year from the date of acceptance of the chemical metering pumps' operation by the City.

PART 2 - PRODUCTS

2.1 DIAPHRAGM METERING PUMPS

- A. Manufacturer:
1. USGI Chemical Feed, Inc., Model Encore 700, to match existing pumps installed at the Owner's facilities. Alternate manufacturers will not be considered.
 2. Metering pumps shall be supplied by an authorized factory representative, factory trained, that can provide local service and parts.
- B. Pump Construction:
1. Each chemical metering pump shall be a motor-driven, reciprocating, mechanically actuated diaphragm type.
 2. Metering pumps shall be supplied with valves and accessories specified.
 3. Each pump shall include:
 - a. Drive motor – 0.5 HP inverter duty
 - b. Variable speed control for AC TEFC motor (stroke frequency) control
 - c. Manual stroke length positioner
 - d. Oil-lubricated gear reducer and cam-and-spring drive mounted in a cast iron housing
 - e. Chemically resistant coating compliant with Section 09 96 00
 4. Each pump shall be provided with a manual local micrometer type stroke length adjustment mechanism, to permit 0 to 100 percent capacity control while in motion, on the pump head.
 - a. The mechanism shall provide positive repeatable settings within plus or minus 2 percent over the entire range.
 - b. Pump delivery shall be repeatable within plus or minus 2 percent accuracy over a 10:1 range.
 5. Pumps shall be suitable for automatic stroke rate speed control.
 - a. The motor supplier shall carefully review the intended application of the variable speed drive and certify in writing that sizes provided are adequate for continuous or intermittent operations (whichever is the most severe

operating condition) at the rated capacity and ambient temperature ranging from 40 degrees F to 95 degrees F.

6. Each pump shall be mounted to a type 316 stainless steel base.
7. The liquid end shall be physically separated from the drive unit by back plate with weep hole creating an air gap.
8. The diaphragm shall be nylon-reinforced EPDM, elastomer backed, with a steel backing plate and PTFE-faced fluid contact surface.
9. The liquid end shall be PVC. The suction and discharge valve shall be constructed of PVC with Hypalon seals. Check valve balls shall be PTFE.

C. Controls:

1. Each pump shall be provided with an adjustable speed AC motor drive. See Section 16220.
2. Motors shall be suitable for 120VAC, single phase service.
3. Controller shall include speed control for AC motor to vary pump stroke frequency based on an external 4-20 mA pacing analog signal.
4. A 4-20 mA output signal proportional to pump speed shall be provided for each pump.
5. Displays shall include percent of full speed.
 - a. Controller shall have SCADA-interface as shown on Contract I-series Drawings.

2.2 CHEMICAL SYSTEM ACCESSORIES

A. Pressure Relief Valves

1. General:
 - a. Pressure relief valves shall have a suitable range for the metering pump and chemical system application.
 - b. Valves shall be field adjustable with initial seating established, tested, and labeled on the valve at the factory.
2. Hypochlorite Service:
 - a. Valve bottom and top shall be PVC.
 - b. Diaphragm and gaskets shall be Viton.
 - c. Non-wetted fasteners shall be Type 316 stainless steel.
 - d. Connections shall be solvent weld or as indicated on the Drawings.

B. Isolating Valves

1. Isolating valves for hypochlorite service shall be PVC diaphragm valves, Asahi/America Inc. Type 14, or equal.
2. Isolating valves shall comply with Section 15119.

C. Ball Check Valves: PVC body, Chemtrol Series BC, Asahi/America, or equal, with EPDM or Teflon seats/seals.

D. Wye Strainers

1. Wye strainers shall have flanged or screwed ends to remove the strainer screen without removing the valve body from piping. Strainers shall be 20 mesh.

2. Hypochlorite Service:
 - a. Body shall be PVC.
 - b. Gaskets shall be Viton.
 - c. Non-wetted fasteners shall be Type 316 stainless steel.
- E. Pulsation Dampeners:
 1. Each pump discharge shall have a pulsation dampener of the single diaphragm pneumatic type.
 2. The minimum dampener volume shall be 15 times the maximum pump stroke volume for one pump head on each respective pump.
 3. Diaphragm shall be Viton. Other wetted parts shall be PVC.
- F. Calibration Chambers:
 1. For each service, provide a calibration column of height and diameter such that the measurable capacity of the column is as noted below.
 2. Permanently calibrate each column in both gallons and tenths of gallons and in milliliters.
 3. The calibration column shall provide venting for gas/air relief as shown on the Drawings.
 4. Hypochlorite Service:
 - a. Plexiglas acrylic or butyrate pipe with PVC Schedule 80 fittings.
 - b. Fittings shall be solvent weld, threaded, or flanged.
 5. Pump column capacity shall be 4000 milliliters.
- G. Backpressure Regulating Valves:
 1. Backpressure regulating valves shall comply with **Section 15119**.

2.3 SPARE PARTS

- A. Provide the following spare parts:
 1. 2 sets of diaphragms for each high-performance disc type pump.
 2. 1 diaphragm for each pulsation dampener.
 3. 2 sets of gaskets, seals, and O-rings for each pump.
 4. 1 set of inlet and outlet check valves for each pump.
- B. Furnish spare parts per Section 46 05 13.

2.4 SOURCE QUALITY CONTROL

- A. Factory Tests
 1. All pumps shall be shop-tested for capacity and pressure prior to shipment.

PART 3 - EXECUTION

3.1 GENERAL

- A. Mount each pump and motor assembly on an existing concrete equipment pad as shown on the drawings and in accordance with the manufacturer's written recommendations.
- B. Provide factory-trained personnel to check installation and test initial operation.

- C. Installation shall be certified on Manufacturers Installation Certification Form, Section 01 99 00.

3.2 MANUFACTURER'S FIELD SERVICES

- A. Provide field inspection and instruction services by factory-trained service technician of the manufacturer as specified in Section 01820 and Section 01 81 01. Services by a sales representative are not acceptable.
 - 1. Provide minimum one (1) visit of four (4) hours, excluding travel time, to inspect and test initial operation, and make necessary adjustments.
 - 2. Provide minimum one (1) visit of four (4) hours, excluding travel time, to train plant operators.
- B. Complete and submit the following forms in Section 01 99 00:
 - 1. Manufacturer's Installation Certification Form.
 - 2. Manufacturer's Instruction Certification Form.

3.3 TESTING

- A. After completion of installation, field test pumps in accordance with Section 01 81 00 to demonstrate compliance with the performance requirements as specified.
- B. The test shall include operation of the new equipment with the new control system.
- C. The Contractor shall be responsible for labor, chemical, water, power and other costs associated with the diaphragm metering pumps system testing.
- D. Following successful testing and commissioning of associated control loops, and prior to pumping of chemicals, the pumps and piping shall be emptied and dried.

3.4 TRAINING

- A. The pump manufacturer shall provide a factory-trained person experienced in diaphragm type metering pump operation and maintenance for a period of at least four hours to train the plant operators and maintenance personnel.
- B. Training shall conform to Section 01820 and be certified on Manufacturers Instruction Certification Form, Section 01 99 00.

END OF SECTION

SECTION 46 61 23
GRAVITY FILTERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Furnished and installed complete, tested and operating filter underdrains, underdrain media retainer and media as shown on the Contract Drawings and as specified herein for New Filter Nos. 1 through 5.
- B. Washwater troughs are covered in Section 13 34 37.
- C. Furnish and install complete, tested and operating new filter underdrain media retainers and new media as shown on the Contract Drawings and as specified herein for Existing Filter Nos. 1 through 5.

1.2 REFERENCED SECTIONS:

- A. Section 05100 – Structural Metal Framing
- B. Section 13 34 37– Fiberglass Reinforced Components

1.3 REFERENCES

- A. American Water Works Association (AWWA) Standards
 - 1. B100-[01]: Granular Filter Material,
 - 2. B604 Granular Activated Carbon
 - 3. C653: Standard for Disinfection of Water Treatment Plants,
 - 4. American Society of Testing Materials (ASTM):
 - 5. C123: Test Method for Lightweight Particles in Aggregate,
 - 6. C127: Test Method for Specific Gravity and Absorption of Coarse Aggregate,
 - 7. C128: Test Method for Specific Gravity and Absorption of Fine Aggregate,
 - 8. C136: Test Method for Sieve Analysis of Fine and Coarse Aggregates,
 - 9. C1107: Standard Specification for Packaged Dry Hydraulic-Cement Grout (Non-Shrink)
- B. American Society for Testing Materials
 - 1. ASTM C1107 – Standard Specification for Packaged Dry, Hydraulic Cement Grout (non-shrink)
- C. National Sanitation Foundation/American National Standards
 - 1. NSF/ANSI Standard 61 Drinking Water System Components – Health Effects

1.4 SYSTEM DESCRIPTION

- A. The gravity filter system consists of dual-media granular activated carbon (GAC) and sand with dual-parallel block unit underdrains. Filter backwash is accomplished using a combined air only, air/water followed by wash media agitation and finally a high-rate water only backwash.

- B. System components for new Filter Nos. 1 through 5 include but are not limited to the following: washwater troughs, filter underdrains, underdrain media retainer, sand media, and GAC media.

1.5 SUBMITTALS

- A. Shop Drawings: Submit the following as an initial submittal: Product Review category shop drawings of the filter system for review. Include sufficient data to show that the equipment conforms to the Specification requirements, materials of construction, pertinent manufacturer's data, headloss and hydraulic calculations, and descriptions of proposed underdrains, media retainer cap, underdrain lateral anchors, grout, and filter media.. Submit hydraulic calculations signed by a registered engineer in California showing that filter underdrain system conforms to requirements specified in Paragraph 2.01.D. herein.
- B. Samples: Submit 1/2-cubic-foot samples each of the proposed filter media suitable for laboratory sieve analysis and other specified tests, in dust-tight containers. Provide laboratory testing data with sample.
- C. Laboratory Testing: Furnish samples of the media from batches that will be shipped to the site, laboratory size gradation analysis and graphical plots using a log-probability scale. Test results shall verify media conformance to AWWA B100 and B604, Granular Activated Carbon and the Specifications and to samples favorably reviewed before installation on this project.
- D. Manuals: Furnish manufacturer's installation and operation manuals, bulletins, and spare parts lists.
- E. Test Procedure: Submit for review test procedures delineating the methods, equipment, and data collection to be used in conducting required tests.
- F. Affidavits: Furnish affidavits from the gravity filter manufacturer stating that the complete filtration system and associated equipment (per Paragraph 1.01A) have been properly installed and tested and are ready for full time operation.

1.6 QUALITY ASSURANCE

- A. The filter underdrains furnished under this Section shall be of a manufacturer/supplier who has been regularly engaged in the manufacture of the equipment for at least ten years. Demonstrate to the satisfaction of the Engineer that the quality is equal to equipment made by the manufacturers named herein.
- B. Filter underdrain installation under this section shall be performed by Contractor personnel who have been trained by the underdrain supplier in the correct methods to install the underdrain.
- C. The GAC product designated by the Contractor as the material to be supplied for this project shall have at least five (5) years experience in municipal drinking water facilities in North America with a minimum of ten (10) installations.

1.7 WARRANTY

- A. Provide warranty that the underdrain block and underdrain media retainer are free of defects in materials and workmanship for a period of two years after start-up. Copies of the warranty shall be included in the shop drawing submittal.

PART 2 - PRODUCTS

2.1 FILTER UNDERDRAINS

A. General:

1. Furnish and install underdrains, underdrain media retainer, media, troughs, air wash, and appurtenances to fit new Filter Nos. 4 and 5, as shown on the Contract Drawings.
2. Remove and dispose of existing underdrain media retainers (IMS Caps), gravel, sand, and anthracite filter media and furnish and install underdrains, underdrain media retainer, and appurtenances to fit Existing Filter Nos. 1 through 3, as shown on the Drawings.
3. Underdrains shall be the Leopold Universal TypeXA[®]™ underdrain with factory installed IMS media retainer cap as manufactured by the F.B. Leopold Company, or equivalent underdrain and media retainer as manufactured by Roberts Water Technologies, Inc.; or equal.
4. To aid in the placing of grout, provide wood bridging and end plates of chemically resistant materials over the underdrain laterals to prevent grout from entering the laterals. If necessary, modify standard sized modular underdrain lateral units at the factory as required to fit the dimensions of the filter. Provide the proper amount of these special units so a complete filter underdrain system can be installed without any field modifications.
5. Filter underdrain system shall be furnished and installed to perform satisfactorily and as specified when operated under the following conditions:
 - a. Downflow of filtered water up to 8 gpm/sf (19.6 m/h).
 - b. Upflow of backwash air at a rate in the range of 4 scfm/sf (73.2 m/h).
 - c. Upflow of backwash air, together with backwash water. Typical recommended combined air and water rates: 4 scfm/sf (73.2 m/h) and 5 gpm/sf (12.3 m/h).
 - d. Upflow of backwash water (only) up to 25 gpm/sf (61 m/h).

B. Underdrain System:

1. Underdrains:
 - a. Material: High-density structural polyethylene (HDPE)
 - b. Block Dimensions:
 - 1) Laying Length: 48-inch for each modular block unit, or greater
 - 2) Width: Less than or equal to 12 inches
 - 3) Height: Less than or equal to 8.5 inches
2. Underdrain Media Retainer:
 - a. Material: Thermoplastic
 - b. Media Retainer Dimensions:
 - 1) Laying Length: 48-inch each modular block to match underdrain laterals
 - 2) Width: Less than or equal to 12 inches to match underdrain
 - 3) Total Height: 11 inches
 - 4) Bulk Density: 38 - 40 lb/ft³
 - 5) Pore Volume: 30 - 50%
 - 6) Pore Size: 200 micrometer, nominal

- 7) Pressure loss: 6-inches of water at 22 gpm/SF and 60°F water temperature
- 8) Attachment to underdrain: type 316 stainless steel, self-tapping screws and sealant

C. Configuration:

1. Underdrain shall be a parallel lateral design and for air (only), air and water, and water (only) distribution. The blocks shall be arranged end-to-end and mechanically joined to form continuous underdrain laterals approximately equivalent to the width of the filter cells. The joints shall be gasketed, bell and spigot type with internal alignment tabs for proper joint alignment and be air and water-tight. Joints shall be of snap-lock type so that the blocks are joined with integral interlocking snap lugs and lug receptors for ease of assembly and installation.
2. The discharge flow from the top of the blocks into the filter bed shall be provided by approximately twenty-three dispersion orifices per square foot of filter area. The orifices shall be not less than 11/64 inch (4.5 mm) diameter to prevent clogging and shall be recessed from the surface by approximately 1/8 inch (3.2 mm). The top of each orifice shall be encircled by a depression approximately 3/8 inch (9.5 mm) x 3/4 inch (19 mm).
3. The underdrain shall have a horizontal flat top discharge surface, so that the finished filter bottom is essentially flat and level, with above stated dispersion orifices for uniform energy intensity of air and water coverage which direct flow vertically for effective penetration and cleaning of the media.

D. Headloss: When subjected to a flow rate of 20 gpm/sf (48.9 m/h) of filter area the headloss through an underdrain lateral 18 feet (5.5 m) long shall not exceed 45 inches (1140 mm) water column.

E. Grout:

1. Non-shrink grout to comply with ASTM C1107 shall be used as leveling grout and support grout between the underdrain laterals. The cement grout between the laterals has to be fully penetrated around the anchor rods all the way down to the based grout so as to form a solid monolithic structure to hold the laterals against uplift forces. Furnish product consisting of properly proportioned amounts of non-metallic, dimensionally stable material to which water is added, in strict accordance with manufacturer recommendations.
2. Epoxy grout, acid resistant to pH = 6.0, shall be used as a sealant above the non-shrink grout between the laterals. The epoxy grout shall be Sikatop 144 or equal.
3. The non-shrink grout and the epoxy grout shall develop a minimum compressive strength of 3,000 psi in three days and 5,000 psi in twenty-eight days. The grout grade and mix design shall be reviewed by the filter underdrain manufacturer, and be suitable for bonding with the Filter basin's concrete structure.

2.2 FILTER MEDIA

- A. General: Furnish and install media in two layers consisting of silica sand and GAC. The materials shall conform to the requirements of AWWA B100 and AWWA B604 respectively, except as modified herein. The media shall comply with the requirements of the NSF/ANSI 61 Drinking Water System Components – Health Effects standard and the requirements for activated carbon as defined by the Food Chemical Codex (FCC) latest edition published by the U.S. Pharmacopeia.
- B. Provide an additional 10 percent of both GAC and silica sand filter media in 50 lb bags.

C. Uniformly Graded Dual Media: Silica sand bottom layer and GAC top layer. The filter media shall conform to the following requirements after installation and throughout the guarantee period.

1. Size: The depth of layers and grading after all necessary washing and surface scraping has been completed shall be as tabulated below.

Name	Layer	Effective Size	Uniformity Coefficient	Depth of Layer, inches
Silica Sand	1st, Bottom	0.50 - 0.60mm	≤ 1.5	10
GAC	2 nd , Top	1.0 - 1.2mm	1.5	60
Total Depth				70
(After Backwashing and Removal of Fines)				

2. Silica Sand Media:

- a. Washed Central California ocean beach sand as supplied by Cemex, George L. Throop Company, or Roberts Water Technologies. The sand shall be clean, hard, rounded, and free of clay, loam, dirt and organic matter and shall contain no iron or manganese (per criteria specified in Paragraph 2.02.C.4.c) that will adversely affect the filtered water.
- b. The silica sand shall be well-graded. Material showing abnormal grading will be rejected. The particle size shall be determined by testing through
- c. U.S. Standard sieves. The percent sizes shall be determined from a plot of the percentages of the material passing each sieve against the rated opening of the sieve, or the equivalent diameter of the grains. When so plotted, the sand shall conform to and fall within the range specified in Paragraph 2.02.C.1.
- d. Silica Sand Material Requirements. Not more than 0.1% of particles shall exceed 2.0 millimeters, and not more than 0.1% shall be smaller than 0.20 millimeters.
- e. The specific gravity of the sand shall be ≥ 2.5.

3. GAC Media:

- a. The bidder shall supply 100% virgin GAC for the initial fill of the filters.
- b. GAC media shall be Filtrasorb 820 as manufactured by Calgon Carbon Corporation, Cabot Norit as manufacturerd by Cabot Corporation or approved equal. Approved equal products must be pre-approved by the Engineer prior to the bid. Supplier must submit a sample for testing, including rapid small scale column testing by a third party testing facility at least thirty (30) days prior to the bid to confirm product conformance with all specifications in this section and to confirm pilot and bench scale testing. Supplier shall be responsible for all testing and analytical costs of its proposed GAC media.
- c. The coal used to produce the GAC media shall be mined and the corresponding GAC manufactured in the United States of America.
- d. The GAC shall be manufactured in a facility certified to conform to the Management System Standard: ISO 9001:2000 or later quality standards and at the specific plant or site holding such certification. A copy of the valid certificate must be submitted with bid, with the understanding by all parties that ANSI/NSF assures the GAC against toxicological hazards only. ISO 9001:2000 or later certification assures the GAC of consistent

- conformance to stated product quality and standards listed in the specifications.
- e. The GAC must be a 100% re-agglomerated bituminous coal based product, sized to a granular form prior to thermal activation. The following materials shall not be accepted if submitted in lieu of the required product, nor may any amount of these materials be blended into a mix with the required re-agglomerated, bituminous coal-based product:
 - 1) Broken pellets, regardless of base material
 - 2) Direct activated GAC, regardless of base material
 - 3) Lignite-based GAC
 - 4) Peat-based GAC
 - 5) Wood-based GAC
 - 6) Coconut-based GAC
 - 7) Sub-bituminous based GAC
 - 8) Anthracite based GAC
 - f. The GAC shall be capable of removing natural organic matter, color, tastes, odors and other organic contaminants from water.
 - g. Bidder shall indicate the source of coal, carbon manufacturing location, a description of the re-agglomeration/thermal process and capacity of the manufacturing facility. The (Engineer/City) reserves the right to inspect the GAC manufacturing and thermal processing facility.
 - h. The GAC media shall be certified for use in potable water treatment facilities in accordance with ANSI/NSF Standard 61.
4. Materials Testing Requirements: All filter media shall meet physical and chemical requirements listed herein below.
- a. Silica Sand Media:
 - 1) Furnish sample of silica sand media to the Engineer for testing and obtain favorable review prior to shipment of any material to the site. Submit the sample in tight jars not less than one- quart size with proper labeling. The filter media delivered to the project site shall be equal in all respects to the favorably reviewed samples. Samples of the media shall be collected and may be retested by the Owner following installation and scraping, and will not be accepted unless it tests equal in all respects to the favorably reviewed samples.
 - 2) Specific Gravity: The average apparent specific gravity shall be determined by the procedure set forth in ASTM C128, which provides for soaking the sample in water for 24 hours.
 - 3) Acid Solubility: Acid solubility of gravel will be tested in accordance with Section 5.3.1 of AWWA B100, Standard Specification for Filtering Material. Solubility of samples shall not exceed more than 2.5% by weight.
 - 4) Manganese and Iron: sand media will be tested for soluble manganese and iron by the following method. Individual samples of each type of media of 100 grams each will be subject to immersion in 500 ml of distilled water of straight consecutive fill and draw elutriations of a minimum of at least 1/2-hour each. The final elutriate will be tested. The amount of manganese in the elutriate shall be less than 0.2 ppm. The amount of iron in the elutriate shall be less than 0.5 ppm.

- 5) Size: Size of sand will be tested in accordance with AWWA B100 Standard Specifications for Filtering Materials.
 - 6) Shape: Irregular shape of filter media particles will be cause for rejection. Microscopic analysis of samples of media to determine shape characteristics will be conducted. Silica sand shall not have more than 10% of the total weight or number of particles thin or flat, as defined by one dimension exceeding three times the other dimension.
 - 7) Alkaline Solubility: Solubility in 1%, 190°F sodium hydroxide shall not exceed 3% by weight for anthracite coal.
 - 8) The silica sand media shall be certified for use in potable water treatment facilities in accordance with ANSI/NSF Standard 61.
- b. GAC Media:
- 1) Pre-bid samples:
 - a) Samples shall be submitted to the (Engineer/City) prior to the bid date. One (1) sample shall be submitted for each activated carbon type to be supplied. Samples shall be no less than 2 lb. and shall be accompanied with a Certificate of Analysis. The Certificate of Analysis shall clearly state the name of the company which manufactured the GAC, the name and location (city, state/province, country) of the manufacturing facility where the sample GAC was manufactured, and shall, include the numeric values for all technical parameters as listed in 2.02.C.4.b.3.
 - b) Failure to comply with the pre-bid sample requirement shall be considered non-responsive and bid shall be rejected.
 - 2) Pre-shipment samples:
 - a) After award but prior to GAC delivery to site, pre-shipment samples of the actual lots to be supplied shall be submitted to an independent laboratory mutually agreed upon between the Engineer/City and the manufacturer.
 - b) The samples shall be accompanied with a Certificate of Analysis and shall meet all requirements as previously set fourth for pre-bid samples.
 - c) The number of samples to be submitted shall be in accordance with AWWA B604, latest edition. Based on the project size, the manufacturer shall determine the lot size and in turn shall provide the appropriate number of samples to be considered representative per AWWA B604, latest edition.
 - d) The Engineer/City may elect, at their cost, to independently test any or all submitted pre-shipment samples at a mutually agreed upon independent testing laboratory to confirm conformance with the specifications. These samples shall be in addition to the samples referenced in 2.02.C.4.b.2.a and shall also be submitted in accordance with AWWA B604, latest edition.
 - e) Failure of the pre-shipment samples to meet specifications shall be cause for the Engineer/City to refuse shipment of GAC.

- f) Manufacturer shall not be given approval to ship GAC until pre-shipment samples meet specifications.
- 3) Product as packaged (confirmed by pre-shipment sample testing) shall meet the following specifications:

Product Specification:	Value	Test Method
Iodine Number (mg/g), min.	900	ASTM D4607
Moisture, weight %, max.	2	ASTM D2867
Effective size, mm	1.0 – 1.2	ASTM D2862
Uniformity Coefficient, max.	1.5	ASTM D2862
Abrasion No., min.	75	AWWA B604
Trace Capacity Number, (mg/cc), min.	9	TM-79, TM-85 (converted to TCN)
Screen Size (US Sieve), weight %		
* Larger than No. 8, max.	5	ASTM D2862
* Smaller than No. 20, max.	4	ASTM D2862
Ash, Max.	10%	ASTM D2866
Typical Property	Value	
Apparent Density, g/cc, min.	0.56	ASTM D2854
Water Extractables	<1%	AWWA B604
Non-Wettable	<1%	AWWA B604

- 5. Inspection:
 - a. Filter media (sand and/or GAC) may be inspected at the Contractor's plant prior to shipment. Notify the Engineer of when the various filter media will be ready to ship at least 10 days prior to shipment. Provide samples of the shipment batches for physical and chemical analysis per AWWA B100 to ascertain if they match the characteristics of the earlier favorably reviewed samples. Do not ship the sand and GAC media to the job site until it's favorably reviewed by the Engineer.
 - b. Provide samples of the filter media (sand and GAC) being placed into the filter initially to assure that the filter media actually being installed meets the physical and chemical characteristics specified herein, and matches samples favorably reviewed for shipment from the Contractor's plant. If the filter media tested during placement does not meet the subject Specifications or closely match that favorably reviewed, it shall be removed by the Contractor and replaced with suitable filter media.
- 6. Cleaning: Sand filter media shall be washed and screened before shipment. If, in the opinion of the Engineer, there is an excessive amount of fines, organic material or odor in the filter media, they shall be rewashed at the site until satisfactory, prior to installation.
- 7. Shipment:
 - a. Shipment of the filter media (sand and GAC) shall be in manufacturer's standard packaging of up to one ton in weight suitable for outdoor storage.
 - b. Bags shall be stacked on pallets in such a manner as to prevent breakage or damage to the bags and spillage of the material during shipment to the

jobsite. Any broken bags shall be credited against the bid amount based on the calculated cost per bag.

PART 3 - EXECUTION

3.1 UNDERDRAINS

- A. Install the underdrain system in strict accordance with the manufacturer's instructions. Place the filter bottoms on a leveling course of grout having a minimum thickness of 3/4 inch and a maximum thickness of 1-1/4 ". New filter floor shall have a rough surface (broom finish with minimum 1/8" groove) before placing floor grout. Contractor shall perform pull-out strength tests, in accordance with Section 05100, on 33% of all steel hold down hardware, located between adjacent rows of tile underdrains that connect/anchor the underdrains to the filters' concrete floor to verify anchors are properly bonded to the concrete floor. The hold downs shall be tested to withstand a 600 lb uplift force. Install the underdrains, which shall come from the factory with the IMS or underdrain media retainer already attached, in strict accordance with the filter manufacturer's installation instructions that have been successfully used on previous projects. Install grout in a manner that avoids contacting with, and plugging of media retainer.
- B. Testing of Filter Underdrains: After the underdrains have been installed and allowed to set for at least three days, or as required by the grout manufacturer (whichever is longer), and with the manufacturer's recommendation to proceed, test the filters in the presence of the Engineer, by backwashing at a rate of 20 – 23 gallons per minute per square foot. Investigate and correct any irregularities in the water surface during backwash. Thoroughly clean all clogged underdrain orifices and IMS or media retainer until a condition of uniform flow is observed. Receive the Engineer's favorable review of underdrain installation prior to placing any filter media.
- C. Protection of Underdrains: After the underdrains have been installed, cover them to prevent dust, dirt or other foreign matter from plugging the porous cap.

3.2 FILTER MEDIA INSTALLATION

- A. Prior to installing filter media, Contractor shall install washwater troughs in accordance with the Section 13 34 37.
- B. Dual Media: Remove all debris from the each filter before placement begins. Clean dirty media before filling begins. Complete each layer to the indicated thickness before the next layer above is started. Do not stockpile silica sand or GAC at the job site unless it is bagged or in closed containers.
- C. GAC installation shall be performed by either the GAC manufacturer or the General Contractor under the supervision of the GAC manufacturer. The GAC installation shall be under the direct supervision of the GAC manufacturer's employee, having a minimum of five (5) years of experience in performing carbon exchanges. Supervision by a third party or agent shall not be allowed. The GAC manufacturer shall submit resumes of supervisors capable of performing carbon installations, indicating qualifications, years of experience and location.
- D. Place the media in accordance with the following schedule:
 - 1. Carefully and slowly fill the filter with water to the indicated depth.
 - 2. Slowly place the media at different locations throughout the filter bed until the calculated volume has been placed.
 - 3. Backwash silica sand layer once. The backwash rate has to be high enough to fluidize the media (refer to Table 2 in AWWA B100 for the required fluidization backwash rate). After the initial wash, scrape the fine material from the surface of the filter media in accordance with AWWA B100. Backwash the filter three more

times after GAC media is placed, at a rate of 22 gallons per minute per square foot of filter area for approximately 15 minutes. The washwater shall be initially applied at the start at a rate not to exceed two gallons per minute per square foot of filter area and gradually increased.

4. Drain the filter following each backwash and remove very fine materials to a depth of 1/2-inch from the top surface and rake each media layer and add necessary quantity to make full bed thickness.

3.3 FIELD SERVICES, STARTUP, FOLLOW-UP AND WARRANTY PERIOD

- A. The filter underdrain manufacturer shall provide a factory-trained representative during installation to ensure that installation is conducted in strict accordance with the manufacturer's instructions and recommendations.
- B. Successful testing must be completed prior to final acceptance. During the warranty period after final acceptance, the underdrain manufacturer shall, upon call, provide advice to the Owner within 24 hours of operational problems or difficulties. If the condition cannot be resolved within 24 hours by the Owner, the manufacturer shall, upon call, go to the site within 48 hours and correct the condition.

3.4 FIELD SERVICE

- A. The filter underdrain manufacturer shall inspect the installation and verify that the filter underdrain system was installed in the correct manner. In addition, the filter underdrain manufacturer shall witness the performance tests. Inspection and supervision shall be for a period of at least twelve 8-hour days, not necessarily consecutive. The cost of this service shall be included in the Contract price.
- B. The filter underdrain manufacturer shall recommend adjustments in water backwash rates and filter backwash controls for proper operation of the filter components supplied.
- C. The filter underdrain manufacturer shall provide a trained field engineer to instruct operating personnel in the proper use and maintenance of the filters. The operational instruction shall be for a period of five 8-hour days, not necessarily consecutive. This time is in addition to the time specified in Paragraph 3.04.A.
- D. Successful testing must be completed prior to final acceptance. During the two-year warranty period after final acceptance, the underdrain manufacturer shall, upon call, provide advice to the Owner within 24 hours of operational problems or difficulties. If the condition cannot be resolved within 24 hours by the Owner, the manufacturer shall, upon call, go to the site within 48 hours and correct the condition.

END OF SECTION