General Conditions and Standard Specifications

2005 Edition

San Diego County Water Authority
General Conditions and Standard Specifications

2005 Edition

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San Diego County Water Authority
SAN DIEGO COUNTY WATER AUTHORITY

GENERAL CONDITIONS AND STANDARD SPECIFICATIONS

2005 Edition

Use of This Document:

The San Diego County Water Authority General Conditions and Standard Specifications are to be used on construction and material procurement projects administered by this agency. Typically, a separately bound document containing the bidding requirements, the contract, insurance certificates, bond forms, additional project specific specifications, and any supplements to the General Conditions and Standard Specifications will be prepared for each project.

The General Conditions and Standard Specifications - 2005 Edition is the sixth edition of this document and is intended to replace all previous editions. The San Diego County Water Authority may issue periodic revisions or may revise and reprint this entire document at its discretion.

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GENERAL CONDITIONS

SECTION 1 RULES OF INTERPRETATION AND DEFINITIONS

1.1 RULES OF INTERPRETATION

The following rules of interpretation apply to each of the contract documents:

(a) The table of contents and any titles, headings and captions preceding the text of articles, sections, subsections or paragraphs of any of the contract documents are solely for convenience of reference and shall not affect the meaning, construction or effect of any text.

(b) When used to describe an action by or on behalf of the Water Authority, unless otherwise expressly stated or from the context a different meaning is plainly evident, the words “directed,” “required,” “permitted,” “ordered,” “designated,” “prescribed,” and their synonyms, describe an act of the Engineer; similarly, unless otherwise specified, the words “approved,” “accepted,” “acceptable,” “satisfactory,” or their synonyms, mean to the approval or satisfaction of the Engineer.

(c) Words designating the singular number include the plural number and vice versa.

(d) The words “include” and “including” shall not be interpreted as words of limitation but instead shall be interpreted as the phrases “including, but not limited to” or “including, without limitation.”

(e) The rule of interpretation that construes contract language against the party responsible for drafting shall not apply to the contract documents. Neither party shall be held to a higher standard than the other party in the interpretation or enforcement of the contract documents.

(f) Figures given in the specifications or upon the plans before or after the word “elevation”, or an abbreviation of it, mean distances in feet above the San Diego County Water Authority datum, as established by the Engineer, which unless otherwise specified shall be “Mean Sea Level” according to the best information available.

(g) For the purposes of Contract interpretation, conflicts, if any, among the contract documents, shall be resolved by applying the following order of precedence:

(1) Change Orders
(2) Contract
(3) Addenda
(4) Permits
(5) Supplemental Conditions
(6) Supplemental Specifications
(7) Plans
(9) All other referenced specifications, uniform construction codes, standards, manuals or other construction or performance requirements.

(h) Conflicts, if any, in the Plans, shall be resolved by applying the following rules and order of precedence:

(1) Figures govern over scaled dimensions;
(2) Detail drawings govern over general drawings;
(3) Project specific drawings govern over standard drawings.

(i) References to persons include reference to firms, companies, associations, joint ventures, general partnerships, limited partnerships, limited liability corporations, trusts, business trusts, corporations and other legal entities, including public bodies, as well as individuals.
References to a section or sections without any other reference mean internal reference to a section or sections of these General Conditions.

1.2 DEFINITIONS

The following definitions apply to each of the contract documents, regardless of whether the initial letter of the word appears in upper or lower case type, unless otherwise specified or unless the context of usage plainly conveys a different definition:

(a) Water Authority: means the San Diego County Water Authority, a California public agency, and its governing body, members of its board of directors, officers, employees and agents.

(b) Addendum or addenda: written or graphic instruments issued prior to the date of opening bids that modify or interpret the contract documents by additions, deletions, clarifications, or corrections.

(c) Beneficial occupancy: the right, but not the obligation, of the Water Authority to occupy and make use of any part of the Work prior to completion.

(d) Bid: the offer of a bidder submitted in response to a notice inviting bids and instructions to bidders.

(e) Bidder: any person or legal entity submitting a bid in response to a notice inviting bids and instructions to bidders.

(f) Board of Directors or Board: when used as a proper noun means the governing body of the Water Authority.

(g) Bonds: the bid bond, faithful performance bond, payment bond, or other surety bond furnished by the Contractor and its California admitted surety in accordance with the contract documents.

(h) Change order: a written order, issued pursuant to the contract documents, to the Contractor signed by the Engineer modifying the scope of Work within the general scope of the contract documents, payment, completion date or other term or condition of the contract documents.

(i) Completion: when the Work has been fully completed as determined by the Engineer and accepted by the Board in accordance with the contract documents.

(j) Completion date: the day established by the contract documents for completion of the Work.

(k) Contract: when used as a proper noun means the portion of the contract documents titled “Contract” and containing the signatures of the parties evidencing a binding commitment to the terms and conditions of the contract documents. The term Contract also refers to the entirety of the contract documents.

(l) Contract documents: Includes the Contract and the following documents relating to the Work:

Procurement Documents
Notice Inviting Bids
Instructions to Bidders
Bid Forms

Bid Proposal
Bidding Sheet
Acknowledgement of Bid Proposal
Bidder’s Plan for Construction
Non-collusion Affidavit
Subcontractor List
Vendor/Supplier and Service Provider List
SCOOP Schedule A-1

Bonds and Insurance Documents

Faithful Performance Bond
Payment Bond
Workers’ Compensation Certificate
Certificates of Insurance and Endorsements

Performance Documents

Supplemental Conditions
Supplemental Specifications
Plans
Addenda to any conditions, specifications or plans issued before bid opening.

Miscellaneous Standard Documents

SCOOP Schedule A-2 – Subcontracting Opportunities and Contact Log
Escrow Agreement for Security Deposits in Lieu of Retention
Issued Change Orders

(m) Contract price: the total consideration in form of United States dollars specified in the Contract and payable to the Contractor according to the contract documents, including, without limitation, any adjustments made by approved change orders.

(n) Contract time: the number of consecutive days stated in the contract documents, commencing from the date of the notice of award, for completion of the Work.

(o) Contractor: the person or legal entity obligated by contract with the Water Authority for the performance of Work required by the contract documents.

(p) Days: when unmodified means consecutive calendar days. Work days means every day except Saturday, Sunday and official Water Authority holidays.

(q) Defective: an adjective which refers to unsatisfactory, faulty or deficient work, materials or supplies, or work, materials or supplies (1) not conforming to the contract documents, (2) not meeting the requirements of any inspection, reference standard test, or approval referred to in the contract documents, or (3) damaged prior to completion unless risk of damage has been specifically assumed by the Water Authority pursuant to the contract documents.

(r) Engineer: the Water Authority’s Director of Engineering, or the Water Authority employee or agent to whom the Engineer has delegated responsibility.

(s) Field order: a written order of the Engineer generally issued at the job site effecting an immediate minor change in a Contractor obligation as specified in Section 3.3(e).
GENERAL CONDITIONS

(t) Laws and regulations: whether used together or singularly means, laws, statutes, adopted regulations, ordinances, rules, permits or other official orders or decrees of governmental agencies or officials applicable to the Contract, the Work, the jobsite or the performance of obligations under the contract documents.

(u) Notice of award: the written notice given to the successful bidder stating that upon compliance with the conditions stated therein, the Water Authority will execute the contract and establishing the time from which the successful bidder is required to execute the contract and perform conditions precedent to execution such as provision of bonds, insurance endorsements and certificates, and other documents required by the contract documents.

(v) Notice of completion: the written notice signed by the Engineer and recorded in the office of the San Diego County Recorder, stating the date of completion, the Water Authority’s interest in the Work, the location of the Work, the name of the contractor, and the kind of Work done by the contractor, according to the terms of the contract.

(w) Notice to proceed: the written notice given by the Water Authority to the Contractor stating that the Contract has been executed and on what date the Contractor may commence performance of work.

(x) Owner or owner of record: the Water Authority.

(y) Permits: permits and other regulatory approvals of a governmental agency issued pursuant to applicable laws and regulations, including permit conditions. Permits include, without limitation, biological opinions issued under the Federal Endangered Species Act, mitigation measures of a final environmental impact report or mitigated negative declaration for the project for which the Work is being performed, mitigation measures of a final environmental impact statement for the project for which the Work is being performed, and mitigation measures of an applicable Natural Communities Conservation Plan.

(z) Plans: when used as a proper noun means the set of drawings, profiles, and cross sections signed or otherwise approved in writing by the Engineer that show the location, character, dimension or details of the Work. Working drawings, shop drawings, and supplemental drawings become part of the Plans when approved by the Engineer according to the contract documents. The phrase “record plans” refers to the set of drawings, profiles and cross sections prepared by the Contractor following construction that show the Work as completed.

(aa) Project: the entirety of the activity that includes the Work. A project may encompass only the Work or may encompass construction by the Water Authority or others.

(bb) Rights of way: land, easements, franchise rights, or other interests in real property held, owned, leased or otherwise belonging to the Water Authority. When used with reference to another public agency, public utility or railroad, the term means the property interest of a public agency, public utility or railroad for street, utility, railroad, or other similar, ancillary or incidental purposes.

(cc) SCOOP: the Water Authority’s Small Contractor Outreach and Opportunities Program.

(dd) Submittal: drawings, diagrams, illustrations, schedules, performance charts, reports, calculations, manuals, samples, brochures, and other writings required by the contract documents to be submitted by the Contractor.

(ee) Supplier or Vendor: a person who supplies material and equipment for the Work, but does not perform labor.

(ff) Writing or written: a communication on paper. A writing may be transmitted by facsimile.
(gg) Work: when initially capitalized, means the entire scope of services required of the Contractor pursuant to the contract documents, including the completed construction. The Work is the result of performing services, furnishing labor, and furnishing and incorporating materials and equipment into the construction, all as required by the contract documents.

1.3 DETERMINATION OF APPLICABLE REFERENCED STANDARDS AND LAWS

(a) Whenever in the contract documents reference is made to published specifications, uniform construction codes, standards, manuals, or other construction or performance requirements, it shall be understood that wherever no date is stated, only the latest published version of the referenced specification, uniform construction code, standard, manual, or requirement in effect at the time the Bids are opened shall apply, unless an applicable law or regulation specifically requires application of a later version to work not yet performed. In case of conflicts between the other contract documents and any referenced specification, uniform construction code, standard, manual, or other requirement, the other contract documents shall take precedence.

(b) References to “as amended” or “as amended from time to time”, when used with respect to laws and regulations refer to the parties’ obligation to comply with such specific applicable law at all times during the contract. Unless otherwise specified, each party’s obligations under the contract documents shall be deemed to require compliance with laws and regulations in effect on the date the contract is executed and as such laws or regulations may be amended and become effective before completion of the Work.

1.4 LIMITATION OF EFFECT OF REFERENCED STANDARDS

No provision of any referenced published specification, uniform construction code, standard, manual, or other requirement, whether or not specifically incorporated by reference in the contract documents, shall be effective to change the duties and responsibilities of the Water Authority, Engineer, or Contractor from those set forth in the contract documents. Nor shall they be effective to assign to the Engineer any duty or authority to supervise or direct the furnishing or performance of the Work or any duty or authority to undertake responsibility contrary to the provisions of the contract documents.

1.5 UNIT PRICING OF ESTIMATED QUANTITY ITEMS

Unless specifically stated otherwise, if the quantity of a unit-priced item is designated on the Bid Forms as an estimated quantity and the actual quantity of the unit-priced item varies by more than 25 percent of the estimated quantity, an equitable adjustment in the Contract Price shall be made upon demand of either party. The equitable adjustment shall be based upon any increase or decrease in costs due solely to the variation exceeding 25 percent of the estimated quantity. If the variation in the estimated quantity is such as to cause an increase in the time necessary for completion, the Contractor may request, in writing, an extension of time, to be received by the Engineer within 10 days from the beginning of the delay. Upon the receipt of a written request for an extension, the Engineer will ascertain the facts and make an adjustment for extending the completion date as, in the judgment of the Engineer, is justified. Adjustments under this section shall be made by change order.

1.6 NOTICE TO WATER AUTHORITY

The Contractor shall deliver required notices to the Water Authority or the Engineer on a work day between the hours of 8:00 a.m. and 5:00 p.m.; such notices are effective when received.

END OF SECTION
SECTION 2 LICENSE REQUIREMENTS

2.1 LICENSE

(a) The Contractor shall possess a valid Class "A" General Engineering Contractor license from the State of California at the time of the bid and throughout the duration of the Contract, including the warranty period.

(b) All subcontractors shall possess a valid contractor license from the State of California of the classification required for the work to be performed by the subcontractor at the time of the subcontract and throughout the duration of the subcontract. Any subcontractor required to be listed by law or the contract documents shall possess the appropriate class of license at the time of listing.

END OF SECTION
SECTION 3   SCOPE OF WORK

3.1 SCOPE OF WORK

(a) The Contractor shall complete the Work in accordance with and by the completion date set by the contract documents at the contract price fixed in the Contract. The Contractor at Contractor’s sole cost and expense shall perform all labor and services and furnish all the materials, tools, and appliances, necessary or proper for performing and completing the Work in accordance with the contract documents. All the labor, services and materials shall be performed and furnished strictly pursuant to, and in conformity with the contract documents, and the directions of the Engineer as given from time to time during the progress of the work under the terms of the contract, and also in accordance with the contract documents and the submittals to be furnished from time to time as provided herein. Contractor shall furnish, erect, maintain, and remove the construction plant and such temporary facilities as may be required. If at any time before the commencement or during the progress of the Work or any part of it, the Contractor’s methods or appliances appear to the Engineer to be unsafe, inefficient, or inadequate for securing the safety of the workers, the quality of work required, or the rate of progress stipulated, the Engineer may order the Contractor to increase their safety and efficiency or to improve the character, and the Contractor shall comply with such orders at the Contractor’s own expense; but neither the making of such demands nor the failure of the Engineer to make such demands shall relieve the Contractor of his obligation to secure the safe conduct of the Work, the quality of Work required, and the rate of progress stipulated in the contract documents.

(b) The Contractor alone shall be responsible for the safety, efficiency, and adequacy of the Contractor’s plant, appliances, and methods, and for any damage which may result from their failure or their improper construction, maintenance, or operation, and shall comply with all mandated safety programs mandated by laws and regulations, applicable industry standards and any additional safety programs specified in the contract documents.

3.2 LAWS, REGULATIONS, AND PERMITS

(a) The Contractor shall keep fully informed of all applicable laws and regulations. If any discrepancy or inconsistency should be discovered in the contract documents, in relation to any such law or regulation, the Contractor shall forthwith report the same in writing to the Engineer. The Contractor shall at all times itself observe and comply with, and shall cause all its agents and employees to observe and comply with all applicable laws and regulations in effect or as amended before final completion of the contract. Except as otherwise explicitly provided elsewhere in the contract documents, all permits and licenses necessary to the prosecution of the Work shall be secured by the Contractor at the Contractor’s own expense.

(b) The Contractor shall not remove any plant or animal species protected by applicable laws or regulations or disturb or remove any sensitive resources except as authorized by the contract documents.

(c) The Contractor shall obtain any permits required under applicable law or regulation for the Work to the extent that such permits were not obtained by the Water Authority or otherwise stated in the contract documents as an obligation of the Water Authority.

(d) The Contractor shall perform the Work in compliance with all permits for the project for which the Work is being performed.

3.3 CHANGE ORDERS GENERALLY

(a) The Engineer on the Engineer’s own initiative or in response to a written request by the Contractor, may by written change order prescribe additions to, deletions of or modifications of the requirements of the Work. For example, change orders may modify the design, line, grade, form, location, dimensions, plan, component, equipment or quantity of the Work.
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(b) Change orders that diminish the quantity or amount of work to be done, shall entitle the Water Authority to a reasonable credit and shall not constitute the basis for a claim for damages or anticipated profits by the Contractor on the diminished work; provided, that if a change renders useless any work already done or materials already furnished or used in the Work, the Engineer shall make reasonable allowance therefore, which allowance shall be binding upon both parties.

(c) A change order shall specify the adjustment in contract time, if any, for the changed Work. If extra work cannot be completed by the completion date, the Contractor shall be entitled to an adjustment in contract time according to proof provided by the Contractor to the Engineer of need for the adjustment.

(d) A change order shall specify the adjustment of the Contract Price, if any, for the changed work.

(e) The Engineer may authorize minor variations from the requirements of the contract documents that do not involve an adjustment in the contract price or the contract time and are consistent with the overall intent of the contract documents. These variations may be accomplished by a field order and will require the Contractor to promptly perform the work involved. If the Contractor believes that a field order justifies an increase in the contract price or an extension of the contract time and the parties are unable to agree as to the amount or extent thereof, the Contractor may make a claim therefore in accordance with Sections 3.5 and 3.6.

(f) During construction and prior to performing any of the Work at the jobsite, the Contractor shall verify the dimensions and quantities specified by the contract documents, and shall immediately notify the Engineer of all discrepancies that are discovered. If the Engineer determines that instructions to address a discrepancy are necessary, the instructions will given by field order or change order. In accordance with Section 5.1, the Contractor may request a change order when warranted due to encountering differing site conditions.

(g) The contractor may request a change order because of the availability of an improved technology or design that would meet or exceed the requirements of the contract documents. Change order requests shall be submitted in writing. Contractor shall not proceed with any changed work unless and until the Engineer issues a change order, unless expressly instructed in writing to proceed with the extra work pending resolution of the change order.

(h) The Engineer may order changes for extra work that, in the opinion of the Engineer, is necessary or desirable for the proper completion of the project. The Contractor shall perform the ordered extra work and furnish the labor, materials and equipment required for its completion. The Contractor will not be entitled to extra time or money for any extra work performed before the change order for that work has been issued by the Engineer, unless expressly instructed in writing to proceed with the extra work pending resolution of the change order.

(i) Work performed pursuant to a change order is subject to all of the provisions of the contract documents and the Contractor's bonds and insurance shall be bound with reference thereto as under the original Contract. If required, the Contractor shall provide the Engineer with new bonds and certificates of insurance and endorsements reflecting the Change Order. The cost to the Contractor or the credit to the Water Authority for revised bonds and insurance premiums shall be included in the revised Contract Price.

3.4 PROCESS FOR ISSUANCE OF CHANGE ORDERS

(a) The Engineer may issue a change order designating the changed work, adjustment to the completion time, if any, and adjustment to the Contractor’s payment or credit, if any. Within three work days of the receipt of the change order, the Contractor shall either (1) sign the change order indicating the Contractor’s acceptance of the terms of the change order, or (2) return the change order without signing it and propose modifications. If the Contractor returns the change order, the Engineer may issue a revised change order, or reissue the original change.
order and direct the Contractor to perform the ordered work subject to the Contractor’s rights of protest and dispute resolution.

(b) Alternatively, the Engineer may submit a change order designating the changed work and requesting an estimate of the cost or credit and schedule for the work. Within 10 days, the Contractor shall prepare and submit to the Engineer a written estimate of cost and schedule for the work. The Engineer may thereafter issue a change order as provided in paragraph (a).

(c) Adjustment in the price paid for a change order due to the Contractor shall be determined by one or more of the following methods in the following order of precedence:

1. Unit prices as stated in the contract documents.
2. Mutually agreed lump-sum or unit prices, based upon current prevailing fair prices for equipment, materials, labor, overhead, and profit. If requested by the Engineer, the Contractor shall furnish an itemized breakdown of the quantities and prices used in computing proposed lump-sum and unit prices for the extra work.
3. Mutually agreed prices for labor, materials, and equipment actually used based on the following:
   i. Cost of labor plus 15 percent for workers directly engaged in the performance of the Work. Cost of labor shall include actual wages paid including employer payments to or on behalf of the workers for health and welfare, pension, vacation, and similar purposes plus payments imposed on payroll amounts by applicable laws and regulations, plus subsistence and travel allowance payments to workers.
   ii. Cost of material plus 15 percent. Cost of material shall include sales tax, freight, and delivery charges. The Water Authority reserves the right to furnish such material as it deems advisable and the Contractor shall not be paid the 15 percent markup on such materials.
   iii. Cost of equipment plus 15 percent for tools and equipment actually engaged in the performance of the Work. Equipment rates shall be the lesser of the actual rental rates or those listed for such equipment in the California Department of Transportation publication entitled Labor Surcharge and Equipment Rental Rates, which is in effect on the date the Work is performed, regardless of ownership and any rental or other agreement, if such may exist, for use of such equipment entered into by the Contractor. If it is deemed necessary by the Engineer to use equipment not listed in that publication, a suitable rental rate for such equipment will be established by the Engineer. The Contractor may furnish any cost data that might assist the Engineer in the establishment of such rental rate. No rental charge shall be made for use of tools or equipment having a replacement cost of $1,000 or less. No payment will be made for equipment on standby or idle time. Payment for equipment will only be made for actual time of use as verified by the Engineer. The equipment rental rates shall include the cost of fuel, oil, lubrication, supplies, small tools, necessary attachments, repairs and maintenance of any kind, depreciation, storage, insurance, and all incidentals. The cost of labor for operators of equipment shall be separately paid for as provided herein.
   iv. Subcontractor invoices to the Contractor plus 5 percent. Subcontractor invoices shall be based upon the above described cost of labor plus 15 percent, cost of material plus 15 percent, and tool and equipment rental rates plus 15 percent. The 5 percent markup to the subcontractor’s invoice shall be applied only once for each separate extra work transaction, regardless of the number of tiers of subcontractors performing the extra work.
   v. The Contractor shall submit to the Engineer for verification, on a daily basis, work sheets showing an itemized breakdown of labor, materials, tools, and equipment used in extra work. No labor, materials, or equipment will be determined to be actually used unless it has been verified daily by the Engineer. Payment shall be made solely for labor, materials or equipment actually used.
(vi) No separate payment shall be made for any item not set forth specifically above, including without limitation, Contractor's overhead, profit, general administrative expense, supervision, bonds and insurance premiums, or damages claimed for delay in prosecuting the remainder of the Work; as such items are deemed included in the percentage markups described previously. The total payment made as provided above shall constitute full compensation for the changed Work.

3.5 PROTESTS

(a) The Contractor may protest any direction, record, ruling or order of the Engineer, including change orders, by filing a written protest not later than three work days following the Contractor’s receipt of the direction, record, ruling or order and before commencement of any work required by the direction, record, ruling or order. The written protest shall clearly set forth all grounds for the protest including specific reference to provisions of the contract documents that govern the issue. The Contractor shall not proceed with any protested work unless and until the Engineer gives written notice directing the Contractor to proceed with the work; once directed to proceed with the work, the Contractor shall do so without delay. Performance of work prior to filing a protest is a waiver by the Contractor of all rights to protest the direction, record, ruling or order. Performance of work after filing a protest and before receiving written notice directing the work to be done is a waiver by the Contractor of the protest with respect to the work performed.

(b) A decision on the Contractor’s protest shall be issued in writing by the Engineer within 14 days, but if a decision is not issued within 14 days, the protest will be deemed denied. After receiving the Engineer’s decision, or after the passage of 14 days without receiving a decision, the Contractor shall have seven days to notify the Engineer, in writing, that the Contractor disagrees with the decision and that a claim will be submitted. The claim shall be filed not later than 30 days of receipt of the Engineer’s decision or 45 days after the date the protest was initially submitted if the protest is deemed denied. The Contractor claim shall be in writing and include all documentation necessary to substantiate the claim, including correspondence, justification, costs or estimates, critical path schedule analysis and other detailed documentation. Resolution of the claim shall proceed in accordance with Section 3.6. The failure of the Contractor to timely file either the notice of claim or, thereafter, a claim is a waiver of the protest and claim.

(c) Claims submitted pursuant to Paragraph (b) above, shall include the certification statement set forth in this paragraph signed by the Contractor. Failure to include and sign the certification statement shall result in the Contractor waiving all right to the subject claim. The Contractor’s certification shall be as follows:

“I hereby certify under penalty of perjury under the laws of the State of California that:

(1) I have thoroughly reviewed the claim for additional compensation, delay damages and/or extension of time, and know its contents;

(2) the claim is made in good faith;

(3) the supporting documentation is accurate and complete to the best of my knowledge and belief;

(4) the amount requested accurately reflects the adjustment in compensation for which the Water Authority is liable; and

(5) I am familiar with California Penal Code Section 72 and California Government Code Section 12650, et seq., and know and understand that submittal of a false claim will be considered fraud subject to prosecution and other serious penalties.”
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(d) Documentation necessary to substantiate the claim shall include, as a minimum, the following:

(1) Statement of claim and the basis for it.

(2) List of documentation relating to claim, including Specifications, plans, reports, schedules, field orders, requests for clarification, etc.

(3) Chronology of events and correspondence

(4) Cost analysis, including all backup financial records supporting the costs analysis, including extended overhead claim analysis

(5) Detailed critical path schedule analysis and backup source documents supporting a delay claim.

(e) All grounds for protests or objections to the records, rulings, instructions, orders or decisions of the Engineer that are not specifically identified or stated in the manner set forth in this Section 3.5 are deemed waived by the Contractor. Contractor agrees that as to any matter not included in a protest or objection in the manner specified in this Section 3.5, the record, ruling, instruction, order or decision of the Engineer regarding that matter is final and conclusive.

3.6 PROCEDURES FOR RESOLVING CLAIMS (PUBLIC CONTRACT CODE SECTION 20104)

(a) For the purposes of this section, “claim” means a separate demand by the Contractor for a time extension; for payment of money or damages arising for work done by, or on behalf of, the Contractor pursuant to the contract documents, and payment of which is not expressly provided for or the claimant is not otherwise entitled to; or for an amount the payment of which is disputed by the Water Authority.

(b) For any claim by the Contractor in the amount of $375,000 or less, the following requirements shall apply:

(1) The claim shall be in writing and include a complete explanation and all documents necessary to substantiate the claim. Claims must be filed within the time period prescribed by Section 3.5. Nothing in this section is intended to extend the time limit or supersede notice requirements otherwise provided for the filing of claim.

(2) For claims up to $50,000:

(i) The Engineer shall respond in writing to any written claim within 45 days of receipt of the claim, or may request, in writing, within 30 days of receipt of the claim, any additional documentation supporting the claim or relating to defenses to the claim the Water Authority may have against the Contractor.

(ii) If additional information is thereafter required, it shall be requested and provided upon mutual agreement of the Engineer and Contractor.

(iii) The Engineer’s written response to the claim, as further documented, shall be submitted to the Contractor within 15 days after receipt of the further documentation or within a period of time no greater than that taken by the Contractor in producing the additional information, whichever is greater.

(3) For claims of over $50,000 and less than or equal to $375,000:

(i) The Engineer shall respond in writing to all written claims within 60 days of receipt of the claim, or may request, in writing, within 30 days of receipt of the claim, any additional documentation

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supporting the claim or relating to defenses to the claim the Water Authority may have against the Contractor.

(ii) If additional information is thereafter required, it shall be requested and provided upon mutual agreement of the Engineer and Contractor.

(iii) The Engineer's written response to the claim, as further documented, shall be submitted to the Contractor within 30 days after receipt of the further documentation, or within a period of time no greater than that taken by the Contractor in producing the additional information or requested documentation, whichever is greater.

(4) If the Contractor disputes the Engineer's written response, or the Engineer fails to respond within the time prescribed, the Contractor may so notify the Water Authority, in writing, either within 15 days of receipt of the Engineer's response or within 15 days of the Engineer's failure to respond within the time prescribed, respectively, and demand an informal conference to meet and confer for settlement of the issues in dispute. Upon a demand, the Water Authority shall schedule a meet and confer conference within 30 days for settlement of the dispute.

(5) If following the meet and confer conference the claim or any portion remains in dispute, the Contractor may file a claim as provided in Chapter 1 (commencing with § 900) and Chapter 2 (commencing with § 910) of Part 3 of Division 3.6 of Title 1 of the Government Code. For purposes of those provisions, the running of the period of time within which a claim must be filed shall be tolled from the time the Contractor submits his or her written claim pursuant to subparagraph (1) until the time that claim is denied, as a result of the meet and confer process, including any period of time utilized by the meet and confer process.

(c) The following procedures are established for all civil actions filed to resolve claims of $375,000 or less.

(1) Within 60 days, but no earlier than 30 days, following the filing or responsive pleadings, the court shall submit the matter to non-binding mediation unless waived by mutual stipulation of both parties. The mediation process shall provide for the selection within 15 days by both parties of a disinterested third person as mediator, shall be commenced within 30 days of the submittal, and shall be concluded within 15 days from the commencement of the mediation unless a time requirement is extended upon a good cause showing to the court or by stipulation of both parties. If the parties fail to select a mediator within the 15 day period, any party may petition the court to appoint the mediator.

(2) If the matter remains in dispute, the case shall be submitted to judicial arbitration pursuant to Chapter 2.5 (commencing with § 1141.10) of Title 3 of Part 3 of the Code of Civil Procedure, notwithstanding section 1141.11 of that code. The Civil Discovery Act of 1986 (Article 3 commencing with § 2016) of Chapter 3 of Title 3 of Part 4 of the Code of Civil Procedure) shall apply to any proceeding brought under this subdivision consistent to the rules pertaining to judicial arbitration.

(3) Notwithstanding any other provision of law, upon stipulation of the parties, arbitrators appointed for purposes of this subsection shall be experienced in construction law, and, upon stipulation of the parties, mediators and arbitrators shall be paid necessary and reasonable hourly rates of pay not exceed their customary rate, and such fees and expenses shall be paid equally by the parties, except in the case of arbitration where the arbitrator, for good cause, determines a different division.

(4) In addition to Chapter 2.5 (commencing with § 1141.10) of Title 3 of Part 3 of the Code of Civil Procedure, any party who after receiving an arbitration award requests a trial de novo but does not obtain a more favorable judgment shall, in addition to payment of costs and fees under that chapter, pay the attorney's fees of the other party arising out of trial de novo.
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(5) The court may, upon request by any party, order any witnesses to participate in the mediation or arbitration process.

(d) For any claim by the Contractor in excess of $375,000, the following shall apply:

(1) The claim shall be in writing and include a complete explanation and all documents necessary to substantiate the claim. A claim must be filed within the time period prescribed in Section 3.5. Nothing in this section is intended to extend the time limit or supersede notice requirements otherwise provided for the filing of claims.

(2) The Engineer shall respond in writing to a written claim within 60 days of receipt of the claim, or may request in writing within 30 days of receipt of the claim, any additional documentation supporting the claim or relating to defenses to the claim the Water Authority may have against the Contractor.

(3) If additional information is thereafter required, it shall be requested and provided pursuant to this section.

(4) The Engineer’s written response to the claim, as further documented, shall be submitted to the Contractor within 30 days after receipt of the further documentation, or within a period of time no greater than that taken by the Contractor in producing the additional information or requested documentation, whichever is greater.

(5) If the Contractor disputes the Engineer’s written response, or the Engineer fails to respond within the time prescribed, the Contractor may so notify the Engineer, in writing, either within 15 days of receipt of the Engineer’s response, or within 15 days of the Engineer’s failure to respond within the time prescribed, respectively, and demand an informal conference to meet and confer for settlement of the issues in dispute. The Engineer may also demand, in writing, within 15 days of its written response to the claim, an informal conference for the same purpose. Upon a demand, the Engineer shall schedule a meet and confer conference within 30 days for settlement of the dispute. If neither party has demanded an informal conference within the specified time periods, and the matter remains in dispute, the Contractor may file a claim as described in this Section.

(6) The Water Authority and Contractor may mutually agree in writing that the meet and confer conference described in paragraph (5), above, shall consist of non-binding mediation. If mediation is mutually agreed on, the mediation process shall provide for the selection within 15 days by both parties of a disinterested third person as mediator, shall be commenced within 30 days of the agreement to mediate, and shall be concluded within 15 days from the commencement of the mediation. Time requirements may be extended upon agreement by both Water Authority and Contractor. However, failure to meet time requirements, or time requirements as extended, shall terminate the mediation. The Water Authority and Contractor shall share equally the mediator’s fee and other administrative costs of conducting the mediation.

(7) If after following the procedures described above in this paragraph (d) the claim or any portion remains in dispute, the Contractor may file a claim as provided in Chapter 1 (commencing with Section 900) and Chapter 2 (commencing with Section 910) of Part 3 of Division 3.6 of Title 1 of The Government Code. For purposes of these provisions, the running of the period of time within which a claim must be filed shall be tolled from the time the Contractor submits his or her written claim under this paragraph (d) until the time the process described in this paragraph (d) is concluded.

END OF SECTION
SECTION 4  GENERAL PROVISIONS AND REQUIREMENTS

4.1 CONTRACTOR’S RISK

(a) Except as otherwise expressly provided in the contract documents, the Contractor is responsible for the Work and shall bear the risk of damage, destruction, or other loss to the Work or delay, damage, or loss to the Contractor from any unforeseen obstructions or difficulties which may be encountered, or from any encumbrances on the rights of way provided, or because the nature or condition of the jobsite is done is different from what is assumed or was expected, or on account any other cause. The exception provided in Public Contract Code Section 7105 is inapplicable to the extent this project is being financed by revenue Bonds issued by the Water Authority.

(b) The Contractor shall be responsible for any material furnished him and for the care of all Work until its completion and final acceptance, and shall at the Contractor’s own expense replace damaged or lost material and repair damaged parts of the Work, or the same may be done at Contractor's expense by the Water Authority. The Contractor shall on a regular basis or when directed by the Engineer remove from the vicinity of the Work all plant, buildings, rubbish, and other material, belonging to him or used under his direction during construction, and in the event of his failure to do so, the same may be removed by the Water Authority at the expense of the Contractor.

4.2 ASSIGNMENT OR DELEGATION FORBIDDEN

The Contractor shall not assign, transfer, convey, sublet, or otherwise dispose of this Contract, or of his right, title or interest in or to the same or any part thereof, or delegate duties or obligations under this Contract, without the previous consent in writing of the Engineer; and he shall not assign, by power of attorney or otherwise, any of the monies to become due and payable under the Contract, unless by and with the like consent signified in like manner. If the Contractor shall, without such previous written consent, assign, transfer, convey, sublet, or otherwise dispose of the Contract, or of his right, title or interest therein, or of any of the monies to become due under the contract, to any other person, company, or other corporation, the Contract may, at the option of the Water Authority, be terminated, revoked, and annulled, and the Water Authority shall thereupon be relieved and discharged from any and all liability and obligations growing out of the same to the Contractor, and to his assignee or transferee. No right under the Contract, nor any right to any money to become due hereunder, shall be asserted against the Water Authority in law or equity by reason of any so-called assignment of the Contract, or any part thereof, or by reason of the assignment of any monies to become due hereunder, unless authorized as aforesaid.

4.3 SUPERINTENDENCE

The Contractor shall give his personal attention constantly to the faithful prosecution of the Work, and shall be present, either in person or by a duly authorized and competent representative, on the site of the Work, continually during its progress, to receive directions or instructions from the Engineer. The Contractor's representative construction superintendent or foreman shall have full authority to act for, bind, and obligate the Contractor. The Contractor agrees that the Contractor’s representative shall be acceptable to the Engineer and shall serve through completion of the Work unless a replacement representative is approved by the Engineer or the representative ceases to be employed by the Contractor.

4.4 AUTHORITY OF THE ENGINEER

(a) The Engineer shall have the right to inspect the Work, review and observe the Contractor's performance for compliance with the contract documents, determine the amount, quality, and acceptability of the Work, and the fitness of all labor, materials, or equipment which are to be paid for, and is the Water Authority's representative for responding to protests filed under the provisions of Section 3.5.
(b) The right of the Engineer to inspect as provided in paragraph (a) shall not limit the Contractor’s responsibility for performance of the Work or be construed in any manner to shift responsibility for the Work to the Engineer. The Engineer will not be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or safety precautions and programs incident thereto. Engineer will not be responsible for Contractor's failure to perform or furnish the Work in accordance with the contract documents.

(c) The right of the Engineer to inspect the Work and review or observe the Contractor's performance will not include review of, evaluation of, or responsibility for the adequacy of the Contractor's safety measures in, on, or near the construction site.

4.5 Inspection

(a) All materials furnished and all work done under these contract documents shall be subject to inspection by the Engineer. The Contractor shall request inspection upon at least one work day’s prior notice to the Engineer. Work done in the absence of inspection may be required to be removed and replaced under the proper inspection, and the entire cost of removing and replacement, including the cost of all materials furnished by the Water Authority and used in the work removed, shall be borne by the Contractor, irrespective of whether the work removed is found to be defective or not. Work covered up or encased without the approval of the Engineer, shall be uncovered or otherwise exposed as ordered by the Engineer. The Contractor shall bear the entire cost of performing all the work and furnishing all materials necessary for the uncovering or exposing any portion of the Work covered or encased without approval of the Engineer and for any repair or replacement of the Work itself.

(b) Whenever the Contractor arranges to work at night, on weekends or on Authority holidays, or to vary the proposed dates of commencement and completion of each of the various parts of the Work as detailed in the most current construction schedule, or to vary the period during which work is carried on each day, the Contractor shall give two work days prior written notice, including a revised construction schedule, to and receive written permission from the Engineer so that inspection may be provided.

(c) Neither inspection of any material, equipment or portion of the Work, nor failure to inspect, shall relieve the Contractor of any responsibility for the Work under the contract documents. Failure to inspect, or following an inspection, failure of the Engineer to reject material, equipment or any portion of the Work, or the Engineer’s authorization to incorporate any material or equipment into the Work, or to proceed with any portion of the Work, does not constitute a waiver or release of any of the Contractor’s obligations.

4.6 Reimbursement of Overtime Pay for Inspection

(a) Unless otherwise specified, the Contractor shall pay actual premium or overtime differential costs incurred by the Water Authority for supervision, inspection and testing of the Work if the Contractor should elect at any time to conduct his operations on any regular shift of more than 8 hours per day or more than 40 hours per week, or on Saturdays, Sundays, or Water Authority holidays.

(b) Premium or overtime differential shall be that portion which is in addition to the regular pay on a straight time hourly basis, including the direct salary, overhead, fringes, and profit markups when the inspection and testing services are performed by the Water Authority’s contractors; and direct salary (including straight time, overtime or premium pay) and fringes when the inspection and testing services are performed by the Water Authority’s employees. The inspection and testing services overhead, fringe and salary markups of an independent contractor shall be determined according to the Water Authority’s contract with the provider of those services.

(c) The costs determined under this Section shall be deducted by the Water Authority from applicable partial payments due the Contractor.
Prior to the preparation of the final estimate and payment, a Change Order will be prepared adjusting the contract price to deduct the costs for which the Contractor is responsible under this Section.

4.7 INSPECTION OF OFF-SITE FABRICATION

(a) All materials and component equipment manufactured or assembled pursuant to the contract documents for incorporation into the Work shall be subject to inspection by the Engineer at the place of manufacture. Manufacturing activities requiring inspection may include: review of the proposed manufacturing plant to verify its suitability for fabrication of the required materials and appurtenances; fabrication; application of plant-applied linings and coatings; shop testing of all manufacturing processes; and transportation processes.

(b) The Water Authority will be responsible for all costs of in-plant factory inspection, except travel and living expenses incurred by in-plant factory inspectors engaged directly by the Water Authority as provided below. Manufacturing activities performed concurrently at one or more locations, or over multiple work day shifts, will require in-plant factory inspection to be performed by more than one inspector.

(c) If the places of manufacture are located within the California Counties of San Diego, Imperial, Riverside, Los Angeles and San Bernardino, the Contractor shall reimburse the Water Authority for the daily travel expenses incurred by each inspector for each and every day, inclusive of weekends and holidays, inspection is performed at the places of manufacture. Daily travel expenses shall include mileage between the places of manufacture and the Water Authority’s San Diego Office paid at the Internal Revenue Service standard mileage rate, and a per diem allowance for meals and incidental expenses paid at the IRS rate. If the Engineer finds it impractical for inspectors to drive each day to the places of manufacture, in lieu of the above mileage and per diem allowance for meals and incidental expenses, the Contractor shall reimburse the Water Authority for the full IRS per diem rate (including meals, incidental expenses and lodging) for each inspector for each and every day, inclusive of weekends and holidays, inspection is performed at the places of manufacture.

(d) If the places of manufacture are located outside the five California counties listed above, the Contractor shall reimburse the Water Authority for all travel expenses incurred by each inspector from San Diego to the places of manufacture, and for all living expenses for each and every day, inclusive of weekends and holidays, during the duration of the inspection performed at the places of manufacture. Travel and living expenses shall include round-trip unrestricted airfare from San Diego, ground transportation from the destination airport to hotel, hotel accommodations, daily round-trip travel from hotel to places of manufacture, and a per diem allowance for meals and incidental expenses paid at the IRS San Diego location rate. For each calendar month that in-plant factory inspection is required, the Contractor shall reimburse the Water Authority for two unrestricted round-trip airfares per inspector.

(e) Reimbursable travel expenses paid for by the Contractor shall be deducted from the Contractor’s monthly progress payment.

4.8 ACCOMMODATION OF INSPECTIONS AND EXAMINATIONS

The Contractor shall furnish the Engineer every reasonable accommodation for ascertaining whether the Work is in accordance with the requirements and intention of the contract documents even to the extent of uncovering or taking down portions of finished work which have been previously approved or authorized to be covered. Should such previously approved work thus exposed or examined prove satisfactory, the uncovering or taking down and the replacing of the covering or the making good of the parts removed, shall be paid for as extra work. Should the work exposed or examined prove unsatisfactory, the uncovering, taking down, replacing, and making good shall be at the expense of the Contractor, and the Contractor shall be charged with the cost to the Water Authority of any materials furnished by the Water Authority for the unsatisfactory work and its replacement in excess of the requirements for satisfactory original construction. No extension of time shall be made for the uncovering, taking down, replacing and making good unsatisfactory work. The inspection and approval of any work shall not relieve contractor from the responsibility of meeting all requirements of the contract documents, even if the inspection missed or overlooked defective work.
4.9 DEFECTIVE WORK OR MATERIAL

(a) The inspection of the any component of the Work shall not relieve the Contractor of any obligations to perform the Work in accordance with the contract documents, and defective work shall be made good, and unsuitable materials may be rejected, notwithstanding that such work and materials have been previously inspected by the Engineer and accepted or estimated for payment. If the Work or any part of it is found defective at any time before the final acceptance, the Contractor shall forthwith make good such defect without compensation in a manner satisfactory to the Engineer, and shall be charged for any excess material furnished by the Water Authority; provided, that in the event the Engineer finds that the said defect necessitating the repair or removal of completed work is due to the use of materials furnished by the Water Authority then the Contractor shall be entitled to a change order for the cost of removing and replacing of the defective work or for its repair as ordered, and the Water Authority shall furnish without charge to the Contractor satisfactory material to replace that previously furnished by the Water Authority.

(b) If any materials furnished or selected by the Contractor for use in the Work are rejected by the Engineer as unsuitable or not in conformity with the contract documents, the Contractor shall forthwith remove such materials from the jobsite and, if disposal is required, dispose of such materials in accordance with all applicable laws and regulations.

(c) If the Contractor fails or neglects to make ordered repairs of defective work or to remove rejected materials within a reasonable period of time after receipt of a written notice from the Engineer ordering the Contractor to do such repair work or remove such materials, the Engineer may make the ordered repairs or remove the rejected materials and deduct the cost thereof from any monies due the Contractor.

4.10 MATERIALS, WORKMANSHIP, AND TESTS

(a) The Contractor shall submit samples, specimens, or test pieces of materials to be furnished or used in the Work as the Engineer may require. All materials must be new and of the specified quality and equal to approved samples, if samples have been submitted.

(b) The Contractor shall furnish three complete, certified copies of mill-test and factory reports, showing chemical and physical properties of materials to be used in the Work, made in accordance with the applicable Specifications for the material, as provided in these Specifications or as the Engineer may require. All certificates shall be furnished and all tests and analyses required in connection with the contract documents shall be made at the Contractor's expense.

(c) Samples and test specimens required under the Specifications shall be furnished and prepared ready for testing in ample time for the completion of the necessary tests and analyses before the articles or materials are to be delivered or used.

(d) Inspection of the articles or materials may be made after delivery at the jobsite and at the expense of the Water Authority. In the event that any material at the jobsite is rejected by the Engineer on account of failure to pass inspection or test, the Contractor shall promptly replace the materials. Inspection will be made as promptly as practicable, but may not, in all cases, be made prior to completion of the Work.

(e) The cost of providing samples, reports and materials for inspection or testing shall be borne by the Contractor. The cost of remediation or replacement of any work, material, part or component that fails to meet standards as a result of any inspection or test shall be borne by the Contractor.

END OF SECTION
SECTION 5  JOBSITE REQUIREMENTS

5.1  SITE CONDITIONS

(a) The Contractor is responsible for all site conditions except subsurface or latent conditions that are materially different from those indicated by the contract documents or are of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in work of the character contemplated by the contract documents, or that could not have been discovered by the Contractor upon reasonable pre-bid inspection and testing as specified in the Instructions to Bidders.

(b) The Contractor shall promptly, and before the following conditions are disturbed, notify the Engineer, in writing, of any:

(1) Subsurface or latent physical conditions at the site differing from those indicated in the contract documents.

(2) Unknown physical conditions at the site of any unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in Work of the character provided for in the contract documents.

(3) Material that the Contractor believes may be material that is hazardous waste, as defined in California Health and Safety Code Section 25117, that is required to be removed to a Class I, Class II, or Class III disposal site in accordance with provisions of existing law.

(4) Asbestos or other hazardous substance, subject to Health and Safety Code Sections 25914, et seq., which is not disclosed in the contract documents

(c) Upon notice by the Contractor, the Engineer shall promptly investigate the conditions. If it is found that the conditions could not have been contemplated by the parties at the time of bid, through reference to the bid documents or through proper investigation by the Contractor as required by the contract documents, and cause a decrease or increase in the Contractor's cost of, or the time required for, performance of any part of the Work, the Engineer shall address the matter through a change order.

(d) If asbestos or other hazardous substance is discovered which is not disclosed in the contract documents, the removal of such shall be performed pursuant to a contract separate from any other work to be performed as required by Section 25914.2 of the Health and Safety Code.

(e) In the event that a dispute arises between the Water Authority and the Contractor whether the conditions materially differ from those disclosed in the contract documents or should have been contemplated by the parties at the time of bid, through reference to the bid documents or through proper investigation by the Contractor as required by the contract documents or cause a decrease or increase in the Contractor's cost of, or time required for, performance of any part of the Work, the Contractor shall not be excused from any scheduled completion date provided for by the contract, but shall proceed with performance under the contract. The Contractor shall retain any and all rights provided either by the contract documents or by law pertaining to the resolution of disputes and protests between the Water Authority and the Contractor.

(f) Nothing in this section shall relieve the Contractor of the obligation to pay all fees and costs associated with removal and cleanup of any hazardous material or waste used at, or brought to, the jobsite by the Contractor.

(g) Any plan required to be submitted by the Contractor prior to excavation showing the shoring, bracing, sloping, and similar excavation requirements will not be accepted by the Engineer if the plan is based on subsurface conditions that are more favorable than those revealed by the reports referenced in the Instructions to Bidders unless the Contractor submits subsequent reports or tests.
5.2 RESPONSIBILITY FOR JOBSITE

The Contractor shall be solely and completely responsible for conditions of the jobsite, including safety of all persons and property during the performance of the Work, and the Contractor shall fully comply with all laws and regulations governing the safety of workers and others. The Contractor is responsible for maintaining an orderly project site and providing jobsite security, and to that end shall employ such watchmen or other persons and implement other appropriate security as may be required. At all times unauthorized persons are to be excluded from the project site.

5.3 SAFETY, SANITATION, MEDICAL, AND DRUG AND ALCOHOL REQUIREMENTS

(a) The Contractor shall promptly and fully carry out the safety, sanitary, and medical requirements as stated in the contract documents and as may from time to time be prescribed by the Engineer, to the end that proper work shall be done, and the safety and health of the employees and of the public are preserved and safeguarded. In case such regulations and orders are not observed by the Contractor, they may be enforced by the Engineer at the Contractor's expense. The Contractor shall summarily dismiss and shall not again engage, except with the written consent of the Engineer, any employee or subcontractor who violates the safety, sanitary, or medical requirements. Such discharge shall not be the basis of any claim for compensation or damages from the Contractor against the Water Authority or any of its officers, employees, consultants or agents.

(b) Appropriate first aid facilities and supplies shall be kept at the site of the Work, and the Contractor shall provide and maintain all measures required by the Construction Safety Orders issued by the Division of Industrial Safety of the State of California.

(c) The Contractor shall prohibit the use or possession of intoxicating liquors or controlled substance at the jobsite or in any vehicle or equipment used in performance of the Work. This prohibition shall not apply to use or possession of prescription or non-prescription medication in accordance with prescribed directions.

5.4 PUBLIC SAFETY

The Contractor is responsible for public health and safety until completion of the Work. The Contractor shall comply with all laws and regulations regarding public health and safety. The Contractor shall provide, erect, or maintain temporary fences, plates, over-crossings, trench bridges, bridges, railings, barriers, and traffic control devices, lights, warning signals, guards, street sweeping, trash removal, vector control and other security devices and systems appropriate to assure public health and safety.

5.5 LAND AND RIGHTS OF WAY

(a) The rights of way necessary for the Work will be provided by the Water Authority. Except as otherwise stated in the contract documents, Contractor will be permitted to use available Water Authority right of way, at or near the jobsite, for construction purposes, for the storage of materials and equipment required for the Work, and to secure the storage of materials and equipment, subject to approval of Engineer. However, use by the Contractor shall not be exclusive. Further, no occupancy or temporary residence shall be allowed within the right of way belonging to the Water Authority unless approved in writing by the Engineer. Contractor shall immediately move stored materials or equipment if any occasion arises, as determined by the Engineer, requiring access to the storage area. Materials or equipment shall not be placed on the property of the Water Authority until the Engineer has agreed to the location to be used for storage.

(b) Contractor shall note all right of way or use restrictions which may be imposed on any portion of the project by regulatory agencies or otherwise and coordinate the work accordingly at no extra cost to the Water Authority. The Contractor must ascertain to his own satisfaction the scope of the project and the nature of any other contracts that have been or may be awarded by the Water Authority in the construction of the project, to the
end that the Contractor may perform the Work in the light of such other contracts, if any. Nothing in the contract
documents shall be interpreted as giving the Contractor exclusive occupancy of the rights of way provided.

(c) When two or more Water Authority contractors are working at the same time on the same or adjacent land
in such manner that the work of one contractor may interfere with that of another, the Engineer shall decide which
contractor shall cease work, and which shall continue or whether the work of both contractors shall progress at the
same time, and in what manner. When the rights of way being used by one contractor is the necessary or
convenient means of access for the other contractor, such privilege of access or any other reasonable privilege
may be granted by the Engineer to the contractor so desiring, to the extent, amount, in the manner, and at the
times permitted. No such decision as to the method or time conducting the Work or the use of territory shall be
made the basis of any claim for delay or damage, except as provided in Section 7.4.

(d) The Contractor shall confine construction, including jobsite storage and staging areas, to the rights of way
provided by the Water Authority. Any other land used for construction activities, including storage and staging
shall be provided at the Contractor’s sole expense and liability. The Contractor shall provide the Engineer with
copies of agreements or easements for any land used for construction that has not been provided by the Water
Authority.

(e) As a condition of final written acceptance of the Work, the Contractor shall furnish to the Engineer
written releases from property owners whose land was used by the Contractor or whose property was damaged
because the Contractor’s operations, for any reason, was not confined to the land or rights of way provided by the
Water Authority.

(f) If the Contractor uses land other than the rights of way provided by the Water Authority, or if the
Contractor extends work beyond the construction boundaries established by the contract documents, the
Contractor shall be responsible for compliance with all applicable laws and regulations relating to the use of that
property, including obtaining and complying with any required permits. Any environmental mitigation required
because of the Contractor’s use of such other lands shall not count against any mitigation program funded or
implemented by the Water Authority.

5.6 COORDINATION WITH PUBLIC AGENCIES, UTILITIES AND RAILROADS

(a) The Contractor shall coordinate with public utilities, public agencies and railroad companies all work
within or adjacent to any street, railway track, utility easement, pipeline, lateral, conduit, cable, telephone,
telegraph, or electrical transmission line, irrigation ditch, utility or other similar structure or facility. The
Contractor shall not be entitled to any extension of time or any extra compensation on account of any
postponement, interference, or delay caused by such structures or facility being on the site of the Work except as
provided in Sections 7.3 and 7.4.

(b) The Contractor shall not close or obstruct any portion of any highway, road, or street except pursuant to
an approved traffic control plan or other permit issued by the agency or person having ownership or control of the
highway, road or street. The Contractor shall not prevent free access to fire hydrants or buried valves or any other
facilities owned by others without the permission of the owner. The Contractor shall repair to the requirements of
the agency or person having ownership or control all damage to highways, roads, streets, public utilities and other
facilities caused by Contractor’s work, including damage caused by construction vehicles. Fences subject to
interference shall be relocated or maintained by the Contractor until the Work is finished and then restored to their
original location and condition, unless otherwise specified.

5.7 TRESPASS

The Contractor shall not trespass on property and shall protect property adjacent to the job site from damage from
trespass, removal of lateral or subjacent support, nuisance, or other causes due to the performance of the Work.
5.8 USE OF ASBESTOS PRODUCTS

(a) The intent of the contract documents is to provide asbestos-free components in the Work. Where the contract documents or the referenced Specifications, standards, codes, or tests refer to products containing asbestos, the Contractor shall provide acceptable alternatives under those documents, or in the absence of such referenced alternatives, he shall submit a proposed substitute to the Engineer for review and acceptance. Alternative products will not be required for asbestos cement pipe where the use of such pipe is allowed by the utility owner.

(b) The Contractor shall take all appropriate precautions for protecting against threats to health and safety of the work force and general public arising out of construction involving asbestos. The Contractor shall comply with all applicable laws and regulations for the handling, shipping, installation, and disposal of asbestos.

5.9 CONTRACT DOCUMENTS TO BE KEPT AT WORK SITE

The Contractor shall keep on the jobsite a copy of the contract documents and shall at all times give the Engineer access thereto.

5.10 ACCESS TO JOBSITE

The Engineer and other Water Authority officers, employees and agents, shall at all times have reasonable access to the jobsite and the Work. The Contractor shall be responsible for assuring the safety of the Water Authority’s representatives while at the jobsite. The Engineer and other Water Authority officers, employees and agents shall at all times have reasonable access to all places of manufacture where machinery or materials are being manufactured, produced, or fabricated for use under the contract documents.

5.11 ACCESS TO RECORDS

The Contractor shall permit the Engineer or other Water Authority officers, employees or agents, including auditors, to have reasonable access during normal business hours to original payrolls, vouchers, purchase orders, subcontracts, payment records, invoices, bills of lading, packing slips, delivery tickets and other records as the Water Authority may deem appropriate to monitor compliance with the contract documents.

END OF SECTION
6.1 CHARACTER OF WORKERS

Only skilled and properly licensed and/or certified workers shall be employed on work requiring special qualification. When required in writing by the Engineer, the Contractor or any subcontractor shall discharge any person who is, in the opinion of the Engineer, incompetent, unfaithful, disorderly or otherwise not qualified, and shall not again employ such discharged person on the Work except with the consent of the Engineer. This includes, but is not limited to the discharge or discipline of any employee of the Contractor or its subcontractors or agents who harass or otherwise engage in inappropriate behavior towards Water Authority personnel or the public. Such discharge shall not be the basis of any claim for compensation or damages from the Contractor against the Water Authority.

6.2 EMPLOYMENT OF LOCAL LABOR

The Contractor and all subcontractors will endeavor to give first consideration to residents of the local area when employing laborers for the Work.

6.3 SUBCONTRACTS

(a) The Contractor shall perform not less than the percentage of the Work specified by supplemental condition using the Contractor’s own employees. All subcontractors shall be licensed as required by California law. No subcontractor shall be retained except in compliance with the Water Authority’s SCOOP program. The Contractor is responsible for the performance of all work done by each subcontractor. The Water Authority reserves the right to require discharge or replacement of a subcontractor that is not qualified to perform the work or violates any provision of the contract documents. The contract between the Contractor and subcontractor shall include a copy of Labor Code Sections 1771, 1775, 1776, 1777.5, 1813 and 1815. The Contractor shall comply with the Subletting and Subcontracting Fair Practices Act (Public Contract Code § 4100 et seq.).

(b) Each subcontract shall contain a reference to and incorporate the contract documents. Each subcontract shall provide for its annulment by the Contractor at the order of the Engineer if in the Engineer's opinion the subcontractor fails to comply with the requirements of the contract documents applicable to the subcontracted work. Nothing herein contained shall create any contractual relation between the subcontractor and the Water Authority, or relieve the Contractor of any liability or obligation under the contract documents. The Contractor is fully responsible to Water Authority for all acts and omissions of subcontractors, suppliers, or other persons or entities performing or furnishing any portion of the Work under direct or indirect contract with the Contractor.

6.4 SUBCONTRACTOR SUBSTITUTION

Written authorization from the Water Authority is required prior to substitution of any subcontractor listed in the bid pursuant to State law or the Water Authority’s SCOOP program. Subcontractors may be substituted for any reason stated in California Public Contract Code Section 4107, when a subcontractor has breached the subcontract, or for other good cause shown by the Contractor, except when otherwise prohibited by law. The Water Authority’s SCOOP program shall apply to the substitution of subcontractors.

6.5 DISCRIMINATION IN EMPLOYMENT

(a) Administrative Code Provisions. Contractor acknowledges and agrees to abide by the following provision of the Water Authority Administrative Code Section 2.24.010 that states:

“(a) It is the policy of the Authority to protect and safeguard the right and opportunity of all persons to seek, obtain, and hold employment without discrimination or abridgment on account of race, color, ethnicity, national origin, ancestry, religion, creed, veteran status, physical disability, mental
disability, medical condition, marital status, sex, sexual orientation, age, or other status protected from workplace discrimination by state or federal law. Authority officers, employees and Contractors shall not knowingly deny an Authority opportunity or benefit, discriminate against or harass, any Authority employee, applicant for employment, contractor, vendor, or recipient of Authority services on account of the person’s race, color, ethnicity, national origin, ancestry, religion, creed, veteran status, physical disability, mental disability, medical condition, marital status, sex, sexual orientation, age, or other status protected from workplace discrimination by state or federal law. Authority officers, employees and Contractors shall not knowingly give preferential treatment to any applicant for employment, bidder, contractor, vendor, or recipient of Authority services on the basis of race, color, ethnicity, national origin, ancestry, religion, creed, physical disability, mental disability, medical condition, marital status, sex, or sexual orientation.

“(b) This section shall be interpreted in a manner that is consistent with the California and United States Constitutions and applicable state and federal statutes governing workplace discrimination. The terms used in this section shall have the same meaning as defined in state statutes governing the same subject matter.

“(c) Nothing in this section shall be interpreted as prohibiting bona fide occupational qualifications consistent with applicable state and federal law and reasonably necessary to the normal operation of Authority employment or contracting. Nothing in this section shall be interpreted as prohibiting regulations and policies to prevent nepotism or conflicts of interest.

“(d) Nothing in this section shall be interpreted as prohibiting action taken to establish or maintain eligibility for any federal program, where ineligibility would result in a loss of federal funds to the Authority.”

(b) Civil Rights Act. Contractor agrees to comply with Title VII of the Civil Rights Act of 1964, as amended, the California Fair Employment Practices Act, the Americans with Disabilities Act of 1990, any other applicable federal and state laws and regulations hereinafter enacted, and the Water Authority’s Small Contractor Outreach and Opportunities Program.

6.6 PAYMENT OF WAGES

The issuance as payment for wages of any evidence of indebtedness is prohibited unless the same is negotiable and payable on demand without discount. Wages must be paid at least semi-monthly on regular paydays established in advance, and shall include all amounts for labor or services performed by employees of every classification.

6.7 HOURS OF WORK

(a) Pursuant to the provisions of the California Labor Code, 8 hours of labor constitutes a legal day's work. The Contractor shall forfeit, as penalty to the Water Authority, $25 for each worker employed in the execution of the contract by the Contractor or any subcontractor under him for each day during which such worker is required or permitted to work more than 8 hours in any one day, and 40 hours in any calendar week in violation of the provisions of the Labor Code, and in particular, Section 1810 to Section 1815, thereof, inclusive, except that work performed by employees of the Contractor and his subcontractors in excess of 8 hours per day at not less than one and one-half times the basic rate of pay, as provided in said Section 1815. Payment of any penalty under this paragraph is additional to the obligation to pay overtime to a worker.

(b) Construction work under the contract documents shall be accomplished on a regularly scheduled 8 hour per day work shift basis, Monday through Friday, between the hours of 7:00 AM and 5:00 PM unless otherwise limited or revised by permits for the project, or as specified elsewhere in the contract documents. However, no construction activities, jobsite operations, or off-site fabrication requiring inspection shall be performed by the Contractor on any Water Authority holidays, except in cases of emergency as certified by the Engineer or unless such activities, operations or fabrication have been authorized in writing by the Engineer.
(c) Overtime and shift work (other than that set forth in the preceding paragraph) may be established as a short-term procedure by the Contractor with written notice to and written permission from the Engineer and any other agency having jurisdiction. No work other than overtime and shift work approved by the Engineer shall be done between the hours of 5:00 PM and 7:00 AM, nor on Saturdays, Sundays, or holidays, except such work as is necessary for the proper care and protection of the work already performed or in the case of emergency.

6.8 NO ADJUSTMENT TO CONTRACT PRICE FOR CONTRACTOR’S PAYMENTS FOR OVERTIME OR PREMIUM PAY

Compliance with laws and regulations is the sole responsibility of the Contractor. Payment for overtime work or other premium pay, i.e., work in excess of 8 hours in any one day, or work in excess of 40 hours in any one week, or work performed on a weekend or legal holiday, shall not entitle the Contractor to any compensation for any item of work in addition to that stipulated in the contract price for the kind of work performed, regardless of whether such overtime or legal holiday work may be authorized under the contract documents. In case of extra work ordered by the Engineer, no additional payment will be made to the Contractor because of the payment by him of overtime or legal holiday rates for such work, unless the use of overtime or legal holiday work in connection with such extra work is specifically ordered in writing by the Engineer, and then only to such extent as extra payment is regularly being made by the Contractor to the Contractor’s workers for overtime or legal holiday work of a similar nature in the same locality.

6.9 PREVAILING RATES OF WAGES

(a) In accordance with the provisions of the California Labor Code, the Water Authority has obtained from the Department of Industrial Relations the general prevailing rates of wages in the locality in which the Work is to be performed, and it shall be mandatory upon the Contractor to whom the contract is awarded and upon any subcontractor to pay not less than the specified rates to all workers employed in the execution of the contract. The Contractor shall cause a copy to be posted at the jobsite. Copies of the prevailing rates of wages are on file at the office of the Water Authority, 4677 Overland Avenue, San Diego, California 92123, and are available for review by any interested party on request.

(b) The Contractor shall forfeit as a penalty to the Water Authority $50, or such other sum as determined according the California Labor Code, for each day, or portion thereof, for each worker paid less than the stipulated prevailing rates for any work done under the contract by him, or by any subcontract under him, in violation of the provisions of the California Labor Code. The difference between such stipulated prevailing wage rates and the amount paid to each worker for each day or portion thereof for which each worker was paid less than the stipulated prevailing wage rate shall be paid to each worker by the Contractor.

6.10 EMPLOYMENT OF APPRENTICES

The Contractor shall comply with all applicable Labor Code requirements, including but not limited to California Labor Code Sections 1777.5, 1777.6 and 1777.7 concerning the employment of apprentices by the Contractor or any subcontractor.

6.11 CERTIFIED PAYROLL RECORDS

(a) Pursuant to California Labor Code Section 1776, the Contractor and each subcontractor shall keep accurate 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 by him or her in connection with the work. Each payroll record shall 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.
(2) The employer has complied with the requirements of California Labor Code Sections 1771, 1811 and 1815 for any work performed by his or her employees on the project.

(b) The payroll records enumerated under paragraph (a) shall be certified and shall be available for inspection at all reasonable hours at the principal office of the Contractor on the following basis:

(1) A certified copy of an employee’s payroll record shall be made available for inspection or furnished to the employee or his or her authorized representative on request.

(2) A certified copy of all payroll records enumerated in paragraph (a) shall be made available for inspection or furnished upon request to the Engineer, the Division of Labor Standards Enforcement, and the Division of Apprenticeship Standards of the Department of Industrial Relations.

(3) A certified copy of all payroll records enumerated in paragraph (a) shall be made available upon request by the public for inspection or for copies thereof. However, a request by the public shall be made through either the Water Authority, the Division of Apprenticeship Standards, or the Division of Labor Standards Enforcement. If the requested payroll records have not been provided pursuant to paragraph (b)(2), the requesting party shall, prior to being provided the records, reimburse the costs of preparation by the Contractor, subcontractors, and the entity through which the request was made. The public shall not be given access to the records at the principal office of the Contractor.

(c) The certified payroll records shall be on forms provided by the Division of Labor Standards Enforcement or shall contain the same information as provided by the division.

(d) The Contractor or subcontractor shall file a certified copy of the records enumerated in paragraph (a) with the entity that requested such records within 10 days after receipt of a written request.

(e) Any copy of records made available for inspection as copies and furnished upon request to the public or any public agency by the Water Authority, the Division of Apprenticeship Standards, or the Division of Labor Standards Enforcement shall be marked or obliterated in such a manner as to prevent disclosure of an individual’s name, address, and social security number. The name and address of the Contractor awarded the contract or the subcontractor performing the contract shall not be marked or obliterated.

(f) The Contractor shall inform the Water Authority of the location of the records required under paragraph (a), including the street address, city and county, and shall, within 5 work days, provide a notice of a change of location and address.

(g) The Contractor or subcontractor shall have 10 days in which to comply subsequent to receipt of written notice requesting the records enumerated in paragraph (a). In the event that the Contractor or subcontractor fails to comply within the 10-day period, the Contractor, as a penalty to the Water Authority, shall forfeit $25 for each day, or portion thereof, for each worker, until compliance is effectuated. Upon the request of the Division of Labor Standards Enforcement, these penalties shall be withheld from progress payments then due. The Contractor is not subject to a penalty assessment pursuant to this section due to failure of a subcontractor to comply with this section.

(h) The Contractor shall furnish monthly a copy of each certified payroll record to the Engineer. The Contractor shall be responsible for the submission of copies of payroll records of all subcontractors. Such payroll records shall include the written declarations made under penalty of perjury required by paragraph (a), and shall also be accompanied by a statement signed by the Contractor, or the subcontractor in the case of subcontractor payroll records, indicating that the payroll is complete, that the wage rates contained therein are not less than those required to be paid, and that the classifications set forth for laborers and mechanics, including apprentices and trainees, truly reflect the work performed in each case. After the Contractor or subcontractor starts work on
general conditions

the project and submits a monthly payroll record, payroll records shall continue to be required until all work by the Contractor or subcontractor is complete. If no work was performed during any month, the payroll record shall indicate that fact.

6.12 SCOOP COMPLIANCE MONITORING

The Water Authority will monitor subcontracting activity and Contractor’s compliance with SCOOP commitments. Pursuant to SCOOP requirements the Contractor shall:

1. Pay each subcontractor and supplier undisputed amounts for acceptable performance within 10 days of the Contractor’s receipt of payment for that work from the Water Authority, unless a different payment schedule is authorized in writing by the Engineer.

2. Obtain services, materials and equipment for the Work from the subcontractors, vendors and suppliers of the type and the quantity specified in Schedule A-1, unless otherwise authorized in writing by the Engineer.

3. Submit to the Engineer the monthly and final reports on Schedule A-3. Each monthly report shall be submitted no later than 30 days following the end of each month in which work is performed. The final report, designated as the “Final Report,” shall be submitted upon completion of the Work.

4. Timely submit any additional report and information required by the Water Authority pursuant to the SCOOP.

5. Maintain all required SCOOP reports and corresponding background information for not less than three years after the completion of the Work, or until such time a program audit has been completed by the Water Authority, whichever occurs first.

6.13 SCOOP NONCOMPLIANCE

Failure by the Contractor to fulfill any of the SCOOP requirements constitutes breach of contract and may result in Water Authority-imposed sanctions on the Contractor. Upon determining that a Contractor is not in compliance with SCOOP requirements, the Water Authority may seek, without limitations, the following remedies:

1. Withholding progress payments until the Water Authority deems the Contractor to be in compliance.

2. Withholding an amount equal to the unmet portion of the amount contracted to the subcontractor, vendor, or supplier in question.

3. Suspension or debarment pursuant to the Water Authority Administrative Code Section 4.12.020.

4. Termination of the contract.

END OF SECTION
7.1 TIME AND ORDER OF WORK

(a) The Contractor shall complete the Work by the Completion Date. Adjustment to the Completion Date and extension of Contract Time may be allowed subject to terms provided elsewhere in these General Conditions. The Contractor shall at all times employ such force, plant, materials, and tools as will be sufficient, in the opinion of the Engineer, to perform required activities at a pace sufficient to complete the Work within the Contract Time. If in the opinion of the Engineer, the Contractor has failed or is failing to employ sufficient force, plant, materials, and tools, or, to maintain adequate progress, the Engineer may, at no additional cost to the Water Authority, require the Contractor to increase progress of work. The Contractor shall implement action required to increase progress and report the action or actions to be taken to the Engineer within two work days following the Engineer’s order to increase progress.

(b) Adjustment of the Completion Date and extensions of Contract Time shall be made for time lost due to inclement weather normal for the area where the Work is being performed. If time is lost due to inclement weather, upon written request the Contractor shall be entitled to a non-compensable time extension only. Time extensions for inclement weather shall be granted by the Engineer only if the weather prevents the Contractor from either proceeding with 75 percent of his labor and equipment force normally engaged in the work or proceeding with operations such that at least 60 percent of the total daily time is being spent on the current controlling operation. The "current controlling operation" shall mean any work activity or combination of work activities, considered at the time by the Engineer, which if delayed, will delay the time of completion of the Work. The determination that a day is a non-work day by reason of inclement weather shall be made and documented by the Engineer and Contractor on the day of the inclement weather. A separate determination shall be made for each day during which the inclement weather occurs. No portion of the Work shall be constructed under conditions that would adversely affect the quality or efficiency thereof, unless special means or precautions are taken by Contractor to perform the work in a proper and satisfactory manner. If inclement weather results in saturated ground or other unsuitable construction conditions, the Contractor will confine construction activity to work that will not be affected adversely by such conditions and may be required to undertake such remedial work as necessary to permit construction to proceed.

(c) The time in which the various portions and the whole of the Work are to be performed, and the Work is to be completed, is of the essence.

(d) Contractor agrees to forfeit and pay the Water Authority liquidated damages in the amount per day set forth in the contract documents for each and every day in excess of the contract time, plus approved time extensions. The amounts shall be deducted from any payments due or to become due the Contractor.

7.2 UNCONTROLLABLE CIRCUMSTANCES

(a) Upon Contractor’s written request and submission of substantiating documentation of a delay resulting from an Uncontrollable Circumstance, the Engineer shall give the Contractor a non-compensable extension of time. The Contractor shall submit a written request within seven days of the commencement of the uncontrolled circumstance. Documentation and determination of delays shall be handled in the same manner as change orders, protests and claims under Section 3, except that the Contractor shall not be entitled to a price adjustment.

(b) Prior to completion and acceptance of the Work, the Contractor is responsible for damage or loss to any portion of the Work resulting from an uncontrollable circumstance, except that Contractor may request an extension of the Completion Date as provided in paragraph (a).

(c) “Uncontrollable circumstance” means any act, event or condition that (1) is beyond the reasonable control of the Contractor that justifies the Contractor not timely performing an obligation or complying with any condition required under the contract documents, and (2) materially expands the scope of, interferes with, or
delays the Contractor’s performance of obligations under the contract documents, but only if such act, event or condition is not the result of the willful or negligent act, error or omission, failure to exercise reasonable diligence, or breach of the contract documents on the part of the Contractor. Examples of acts, events or conditions that typically qualify as uncontrollable circumstances include: naturally occurring events (except inclement weather conditions normal for the area where the Work is being performed) such as landslides, underground movement, earthquakes, fires, tornadoes, hurricanes, floods, lightning, epidemics and other acts of God; explosions, terrorism, sabotage, or similar acts of a declared public enemy; extortion; war; blockade; insurrection, riot or civil disturbance; labor disputes, except labor disputes involving employees of the Contractor, its affiliates, or subcontractors, vendors and suppliers; the failure of any subcontractor to furnish services, materials, chemicals or equipment on the dates agreed to, but only if such failure is the result of an event that would constitute an uncontrollable circumstance if it affected the Contractor directly, and the Contractor is not able after exercising all reasonable efforts to timely obtain substitutes; the preemption, confiscation, diversion, destruction or other interference in possession or performance of materials or services by a government agency in connection with a public emergency or any condemnation or other taking by eminent domain of any material portion of the Work. By example, and without limitation, none of the following acts, events or condition shall constitute an uncontrollable circumstance: any delay that would not have occurred but for the Contractor’s failure to comply with its obligations under the contract documents; Contractor’s inability to obtain timely materials or equipment; any work related injuries, accidents or safety violations; any changes in interest rates, inflation rates, wage rates, insurance premiums, commodity prices, currency values, exchange rates or other general economic conditions that significantly increase Contractor’s cost of performing the Work; any change in the financial condition of the Contractor or any subcontractor affecting their ability to perform timely their respective obligations; the consequences of error, neglect or omissions by the Contractor, any subcontractor, or any other person in the performance of the Work; any change of union or labor work rules, requirements or demands which have the effect of increasing the number of employees employed on the Work or otherwise increasing the cost to the Contractor of performing the Work; inclement weather conditions normal for the area where the Work is being performed; any mechanical failure of equipment; or any electric utility power outages except as a direct result of an independent uncontrollable circumstance.

7.3 SUSPENSION OF WORK

(a) The Water Authority may suspend the Work or any portion of the Work as follows:

(1) At any time and without cause for a period of not more than 60 consecutive days by notice in writing to the Contractor. The notice will establish the date upon which work is to be resumed. The Contractor shall be entitled to a change order that adjusts the Contract Price or extends the Contract Time, or both, for additional costs or delays directly attributable to the suspension. The change order shall be processed according to Section 3. The change order is subject to the provisions of paragraph (d) of this Section.

(2) At any time by notice in writing to the Contractor due to an uncontrollable circumstance, action of another government agency or regulatory authority, or environmental considerations, any of which, in the opinion of the Water Authority, adversely affect the Water Authority’s interest if the Work proceeds. The Contractor shall be entitled to a change order that extends the Contract Time in an amount determined by the Engineer and the Contractor. The Contractor will not be permitted an adjustment in price unless the suspension under this paragraph is for more than 60 consecutive days. If the suspension under this paragraph extends for more than 60 days, in addition to a time extension, the Contractor will also be allowed change order to adjust the Contract Price for additional costs directly attributable to the suspension. The change order is subject to paragraph (d) of this section.

(b) If the Contractor is not in default and the Work is suspended for a period of more than 60 consecutive days under paragraph (a)(1), the Contractor may demand in writing that the Contract be terminated pursuant to Section 7.6.
(c) Upon the receipt of a notice of work suspension, the Contractor shall suspend the Work in such manner, sequence, and at such times as the Engineer may direct, continuing only such Work and only until such time or times as the Engineer may direct. Upon written instruction to resume, the Contractor shall promptly resume the Work within the time established by the Engineer and complete all remaining Work, subject to any changes in the Work as may be ordered before or during the time of suspension.

(d) The Contractor shall be granted an extension of time to complete the Work equivalent to the period of suspension, plus reasonable remobilization time. Any allowable adjustment to the price directly attributable to a suspension shall be limited to the reasonable and necessary direct demobilization and remobilization expenses, if any, plus reasonable expenses necessary to protect the Work during the time of suspension as directed by the Engineer. Any adjustment to price shall not include delay damages, extended overhead expenses, lost profits or lost business opportunity, except as expressly required by Section 7.4.

7.4 PAYMENT FOR DELAYS TO CONTRACTOR

(a) As required by Public Contract Code Section 7102, the Contractor will be compensated for the recovery of damages incurred by the Contractor due to delays for which the Water Authority is responsible and which delay is unreasonable under the circumstances involved and were not within the contemplation of the parties. The Water Authority will not compensate Contractor for delays which were reasonable under the circumstances and were within the contemplation of the parties or not otherwise within the scope of the requirements set forth in Public Contract Code 7102. The Water Authority will not be liable for, and in determining direct and unavoidable costs, the Engineer will exclude, all costs which the Engineer determines the Contractor could have avoided by the judicious handling of forces, equipment, or plant.

(b) If the Contractor desires payment for a delay as specified in paragraph (a), the Contractor shall comply with the requirements of Sections 3.5 and 3.6. Any right to recover payment for a delay shall be deemed to have been waived and released as to any claim for which the Contractor does not comply with those Sections.

7.5 TERMINATION OF CONTRACT FOR CAUSE

(a) The Water Authority shall have the right to terminate the Contractor for cause under any one or more of the following circumstances:

1. Contractor’s persistent failure to perform the Work in accordance with the contract documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment, failure to adhere to the progress schedule as approved from time-to-time by the Engineer, failure to adhere to the schedule of values as approved from time-to-time by the Engineer);

2. Contractor’s disregard of applicable laws and regulations;

3. Contractor’s repeated disregard of the authority or orders of the Engineer;

4. Contractor’s repeated or persistent default of any of the provisions of the contract documents;

5. Contractor’s material breach of any provision of the contract documents;

6. Contractor’s failure to perform work for a period of five consecutive work days unless such failure is excused because of inclement weather or uncontrollable circumstance.

(b) If one or more of the grounds for termination exist, the Water Authority, after giving the Contractor and the performance surety five days written notice, may at its sole discretion, without liability for trespass or conversion, take any of the following actions: terminate the service of the Contractor; exclude the Contractor from the site; take possession of the site and Work; take possession of all of Contractor’s tools, appliances, construction
equipment, and machinery at the site; take possession of all materials and component parts, equipment, or machinery stored at the site or for which the Contractor has paid but which are stored elsewhere; use the site, tools, appliances, construction equipment, machinery, parts, and materials to the full extent they could be used by Contractor; finish the Work as the Water Authority may deem expedient; or make demand on the performance bond surety to complete the Work. When the Water Authority terminates the Contractor’s services under this Section 7.5, the Contractor shall not be entitled to receive further payments until the Work is completed. If the unpaid balance of the Contract Price is greater than all claims, costs, losses, offsets and damages (including without limitation all fees and charges of engineers, architects, land surveyors, contractors and other providers of professional services) sustained by the Water Authority arising out of or relating to completing the Work or exercising its rights under this Section, the excess will be paid to the Contractor or the performance bond surety. If the unpaid balance of the Contract Price is less than all claims, costs, losses, offsets and damages (including without limitation all fees and charges of engineers, architects, land surveyors, contractors and other providers of professional services) sustained by the Water Authority arising out of or relating to completing the Work or exercising its rights under this Section, the Contractor will pay the difference to the Water Authority. When exercising any rights or remedies under this Section, the Water Authority shall not be required to obtain the lowest price for the Work performed.

(c) The termination of the Contractor’s services under this paragraph will not affect any rights or remedies the Water Authority may have against the Contractor existing at the time of termination or which may later accrue. Any release of retention or payment by the Water Authority will not release the Contractor from liability.

7.6 TERMINATION FOR CONVENIENCE OF WATER AUTHORITY

(a) Upon five days’ written notice to the Contractor, the Water Authority may, without cause and without prejudice to any other of the Water Authority’s rights or remedies, terminate the Contract.

(b) Upon the service of a notice of contract termination, the Contractor shall discontinue the Work in the manner, sequence, and at such times as directed by the Engineer. The Contractor shall remain responsible for the quality and fitness of the work performed by Contractor before termination of the Contract. All requirements of the Contract pertaining to work completed or to be completed as directed by the Engineer as of the time of termination shall survive the termination, including without limitation, all indemnities, warranties, requirements for preparation of record drawings and completion of any “punch-list” items directed by the Engineer. Contractor shall cooperate with Water Authority with respect to providing information about the work in progress at the time of termination, as requested by the Engineer.

(c) Upon termination of the Contract, Water Authority shall use reasonable efforts to determine and pay to the Contractor within 30 days, without duplication, for the following items:

(1) For completed and acceptable Work executed in accordance with the contract documents before the effective date of termination, including a fair and reasonable amount for overhead and profit on such Work, less any prior payments for the Work. The determined value of the Work, including overhead and profit, shall be consistent with the contract documents, including any schedule of payments or schedule of values.

(2) For documented direct expenses sustained before the effective date of termination in performing services or furnishing labor, materials, or equipments as required by the contract documents necessary for the execution of the uncompleted Work. The determined value of the documented direct expenses, including overhead and profit, shall be consistent with the contract documents, including any schedule of payments or schedule of values.

(3) For reasonable and documented direct expenses, including damages, incurred in settlement or as a consequence of terminated subcontracts;

(4) For other actual expenses reasonably incurred as a direct consequence of the termination.
(d) Notwithstanding the foregoing, the Contractor shall not be entitled to recover any loss of anticipated profit or revenue or other economic loss arising out of or resulting from the termination, including without limitation any claim for anticipated profits on the Work not performed or lost business opportunity.

(e) If the Contractor is terminated under this Section, the Water Authority may, at its option, purchase from the Contractor, all plant, tools, and equipment of the Contractor, including buildings, appurtenances, and road construction improvements, which at the time of the termination are on land of the Water Authority, on street right-of-way, or in transit, or contracted for in writing or temporarily removed for repairs, in use or to be used exclusively on the Work.

(f) If the Contractor is terminated under this Section, the Water Authority may purchase from the Contractor all consumable supplies of the Contractor on hand, or in transit, or on definite commitment, including fuel, lubricants, and materials of construction not incorporated in the Work which, in the opinion of the Engineer, are suitable and required to complete the Work; and the Water Authority shall pay to the Contractor for such consumable supplies the prices paid therefore by the Contractor.

(g) If the Contractor is terminated under this Section, upon request by the Engineer, the Contractor shall provide the Engineer with an itemized inventory and cost account of all plant, tools, equipment, labor and consumable supplies that have been used, are then in use, and were planned to be used on the Work. Further, upon request, the Water Authority shall have the right to audit all of the Contractor’s records relating to costs incurred or planned to be incurred in performing the Work.

7.7 DEDUCTION OF LIQUIDATED DAMAGES FOR FAILURE TO MEET COMPLETION DATE

(a) If the Contractor fails to complete the Work on the Completion Date, the Water Authority shall have the right to deduct the amount of liquidated damages from payments otherwise due to the Contractor. However, if the Water Authority elects not to withhold liquidated damages, failure to do so will not be deemed to be a waiver of the Water Authority’s right to later assess liquidated damages against the Contractor.

(b) When the Contractor is in default because of failure to meet the Completion Date, the Engineer may permit the Contractor to complete the Work and may deduct from any payments liquidated damages as provided in the contract documents. Permitting the Contractor to continue and finish the Work, or any part of it, after the Completion Date shall not operate as a waiver on the part of the Water Authority for any of its rights under the Contract.

7.8 RIGHT TO OCCUPY AND OPERATE PORTIONS OF THE WORK

(a) The Water Authority may occupy and use any separately functioning and usable portion of the Work as soon as that portion is complete if the Water Authority’s occupancy and use will not substantially interfere with the Contractor's performance on the remainder of the Work.

(b) The Water Authority may occupy and use any usable portion of the Work that is substantially complete if the Water Authority’s occupancy and use will not substantially interfere with the Contractor’s completion that portion and with the Contractor’s performance on the remainder of the Work.

(c) The Engineer shall give written notice to the Contractor of the Water Authority’s intent to occupy and use a portion of the Work. The written notice shall include the Engineer’s determination that the portion to be occupied and used is complete under paragraph (a) or substantially complete under paragraph (b), and if substantially complete, of the item or items remaining to complete the Work. The Contractor shall have 10 days following receipt of the notice to object in writing to any determination of the Engineer. The Engineer may thereafter make further determinations and issue a final written statement consistent with this Section relating to the Water Authority’s occupancy and use of completed or substantially completed portions of the Work.
written statement will govern relationship between the Water Authority and Contractor with respect to the portion of the Work occupied and used by the Water Authority. The Contractor shall be permitted reasonable access to the occupied portion of the Work, under conditions specified in the written statement, to complete or correct items of the occupied Work and to complete the unoccupied remainder of the Work.

(d) Occupancy and use by the Water Authority under this Section does not constitute acceptance of the Work. Except as specifically provided in paragraph (e) of this Section, the Water Authority’s occupancy and use of any portion of the Work does not excuse the Contractor from any obligation under the Contract.

(e) The Water Authority’s occupancy and use of Work under this Section shall be subject to the following:

(1) The Contractor shall provide the Water Authority with an endorsement from the insurer providing property insurance under the contract documents covering the additional risks, if any, associated with the Water Authority’s occupancy and use, and acknowledging that the occupancy and use shall not operate to cancel or cause lapse of any insurance relating the Work. The Water Authority shall reimburse the Contractor for any additional premium on account of this requirement.

(2) The Contractor shall provide the Water Authority with any manufacturers’, fabricators’, suppliers’, and vendors’ warranties, operation manuals, use licenses and other documentation applicable to or necessary for operation and maintenance of the portion of the Work occupied and used by the Water Authority. The Contractor shall provide operation and maintenance instruction to the Water Authority personnel as directed by the Engineer.

(3) The Contractor’s general warranty shall apply to the portion of the Work occupied and used by the Water Authority as provided in Section 9.2.

(f) Testing of Work or training of Water Authority personnel as specified in the contract documents shall not constitute operation or acceptance of Work by the Water Authority.

7.9 ACCEPTANCE OF WORK

(a) When in the opinion of the Contractor the Work is complete and ready for acceptance, the Contractor shall give written notice of finished work to the Engineer. Within five days of receipt of the notice of finished work, the Engineer will schedule a meeting with the Contractor to discuss project closeout and acceptance of the Work.

(b) Acceptance of the Work by the Water Authority shall be contingent upon the successful testing, startup, commissioning, and satisfactory operation as a total unit of the completed Work; completing or correcting all items pursuant to the Engineer's inspection; submittal of Operation and Maintenance Manuals, final record documents, all required spare parts and tools, manufacturers' warranties, and releases from permitting agencies and property owners; completion of all other project requirements as specified in the contract documents; and acceptance of the Work by the Board of Directors.

(c) The Engineer will notify the Contractor in writing of the Engineer’s determination whether the project is ready for acceptance and of the date scheduled for acceptance by the Board of Directors. Within 10 days after the date of acceptance by the Board, the Engineer shall record a Notice of Completion.

7.10 ACCEPTANCE OF WORK NOT A WAIVER

Acceptance of the Work by the Water Authority, approval of any order, measurement, or certificate by the Engineer, payment of money by the Water Authority, taking possession of Work by the Water Authority shall not operate as a waiver or release of any claim or cause of action for breach of contract or of any right to enforce any Contract obligation.
7.11 RIGHT OF PROPERTY IN MATERIALS

(a) Nothing in the contract documents shall be considered as vesting in the Contractor any right of property in materials used, after they have been attached or affixed to the Work or the soil, but all such materials shall, upon being so attached or affixed, become the property of the Water Authority.

(b) No equipment, materials or supplies, whether incorporated into the Work or not, shall be purchased by the Contractor or by any of his subcontractors subject to any chattel mortgage or under a conditional sale contract or other contract by which a security or other interest is retained by the seller. The Contractor shall obtain clear title and remove all liens or encumbrances, prior to incorporating any equipment, materials, and supplies into the Work. Engineer may require the Contractor to show proof that he has clear title to all equipment, materials, and supplies used and incorporated in the Work.

7.12 TITLE TO MATERIALS FOUND ON THE WORK

The title to and the right to the use of all water, soil, stone, gravel, sand, minerals, and all other materials found, developed or obtained in the excavation or other operations by the Contractor or any subcontractor or any of their respective employees or agents are hereby expressly reserved for the Water Authority; neither the Contractor nor any subcontractor nor their respective employees shall have any right, title or interest in or to any part thereof, neither shall they, nor any of them, assert or make any claim thereto. Upon written request by the Contractor, and at the discretion of the Engineer, the Contractor may be permitted to use in the Work without charge any such materials which meet the requirements of the contract documents. This Section shall not limit the Contractor's responsibility to dispose of all excess spoils from the Work in accordance with the contract documents.

END OF SECTION
GENERAL CONDITIONS

SECTION 8   INSURANCE AND SURETIES

8.1 INSURANCE

(a) The Contractor shall procure and maintain during the period of performance of this Contract and for 24 months following completion, insurance from insurance companies admitted to do business in the State of California, as set forth in this Section or as additionally required by supplemental condition. These policies shall be primary insurance as to the Water Authority so that any other coverage held by the Water Authority shall not contribute to any loss under the Contractor's insurance. Coverage may be provided by a combination of primary and excess insurance policies, provided all insurers meet the requirements of this Section.

(1) Commercial general liability: Coverage at least as broad as ISO form CG 00 01 10 01 or its equivalent, with no exclusion endorsements.

(2) Automobile liability: Coverage at least as broad as ISO form CA 00 01 10 01, for “any auto,” including owned, non-owned and hired vehicles.

(3) Workers' compensation and employer's liability: Coverage shall comply with the laws of the State of California, but an employer's liability limit of less than $1,000,000 is not permitted. The Contractor may satisfy this requirement by proof of an approved self-insurance program under California law.

(4) Builder's Risk insurance on an "all risk." Coverage shall include Work in progress as well as completed Work prior to acceptance by the Water Authority. The risk of loss for damage to any portion of the Work due to floods and earthquakes is on the Contractor, but insurance for damages from this peril is optional with the Contractor. Such insurance shall include the Water Authority as Loss Payee.

(5) Contractor's Equipment Insurance on an "all risk" basis covering equipment owned, leased or used by Contractor.

(b) General commercial and builder’s risk insurance may have a deductible clause, but not to exceed the lesser of five percent of the Contract Price or $25,000. For other insurances, a deductible or retention may be utilized, subject to approval by the Water Authority.

(c) All insurance shall cover occurrences during the coverage period.

(d) The coverage amount of each policy of insurance shall be as required by the Water Authority by supplemental condition. Builder’s Risk insurance shall be in an amount not less than the contract price.

(e) The insurance policies shall be endorsed as follows:

(1) For general commercial liability and automobile insurance, as well as excess or umbrella insurance covering risks within the scope of that type insurance, the Water Authority, its directors, officers, employees and agents are included as additional insureds with regard to liability and defense of suits or claims arising from the operations, products and activities performed by or on behalf of the Named Insured. The Contractor’s insurance applies separately to each insured, including insureds added pursuant to this paragraph, against whom claim is made or suit is brought except with respect to the policy limits of liability. The inclusion of any person or entity as an insured shall not affect any right which the person or entity would have as a claimant if not so included. Any failure of the named insured to comply with reporting provisions of the policy or breaches or violations of warranties shall not affect coverage provided to the insureds added pursuant to this paragraph. The additional insured endorsement shall provide coverage at least as broad as ISO form CG 20 10 11 85.
GENERAL CONDITIONS

(2) The Contractor’s insurance shall be primary. Any other insurance or self-insurance available to the Water Authority or persons stated in paragraph (1) shall be in excess of and shall not contribute to the Contractor’s insurance.

(3) The Contractor’s insurance shall not be canceled or materially reduced in coverage except after 30 days prior written notice receipted delivery has been given to the Water Authority, except 10 days notice shall be allowed for non-payment of premium.

(4) The workers’ compensation and employer’s liability insurance, and any property insurance shall be endorsed to include a waiver by the insurer all rights of subrogation against the Water Authority and other persons specified in paragraph (1) for losses paid under the terms of the insurance policy. The endorsements required by paragraph (2) may be omitted. The property insurance – loss payee endorsement shall include a provision that the loss shall be adjusted with the Named Insured and paid to the Water Authority.

(f) Unless otherwise specified by supplemental condition, the insurance shall be provided by an acceptable insurance provider, as determined by the Water Authority, which satisfies the following minimum requirements:

An insurance carrier admitted to do business in California and maintaining an agent for process within the state. Such insurance carrier shall maintain a current A.M. Best rating classification of "A- (A minus)" or better and a financial size of $10 million to $24 million (Class V) or better, or a Lloyds of London program provided by syndicates of Lloyds of London and other London insurance carriers, providing all participants are qualified to do business in California and the policy provides for an agent for process in the state and the program assures a financial capability at least equal to the required classification and size for admitted insurers. Workers’ compensation and employer’s liability insurance may be provided the California State Compensation Fund.

(g) Certificates of insurance and endorsements shall be provided by the Contractor and approved by the Water Authority before execution of the Contract. Endorsements may be provided on forms provided by the Water Authority, or substantially equivalent forms provided by the insurer.

8.2 ACCIDENT REPORTS AND CLAIMS

(a) Contractor shall immediately report (as soon as feasible, but not more than 24 hours) to the Water Authority any accident or other occurrence causing injury to persons or property during the performance of this Contract. If required by the Water Authority’s Risk Manager, the report shall be made in writing and shall include, at a minimum: (a) the names, addresses, and telephone numbers of the persons involved, (b) the names, addresses and telephone numbers of any known witnesses, (c) the date, time and description of the accident or other occurrence.

(b) All claims for damages, losses, expenses and other costs, received by the Contractor or the Water Authority, arising out of or resulting from or in connection with the performance of the Work shall be acknowledged by the Contractor by sending written notice to the claimant within 10 days of the Contractor’s receipt of the claim. The written notice shall either: (1) confirm the Contractor’s responsibility for damages and losses, and intent to pay or settle claim directly with the claimant; or (2) confirm the Contractor’s responsibility for prompt investigation and processing of the claim, including identifying the Contractor’s insurance carrier and claims adjuster, describing the Contractor’s or insurance carrier’s procedure for investigating and processing of the claim, and providing a name and telephone number for contacting the representative of the Contractor. A copy of the written notice of claim shall be delivered to the Engineer. Should the Contractor state his intent to pay or settle the claim directly with the claimant, payment or settlement shall be made within 45 days of receipt of the claim. Claims to be submitted to the Contractor’s insurance carrier shall be forwarded to the insurance carrier within 30 days of receipt of the claim. Failure by the Contractor to send the written notice of claim, or to notify the Engineer of any claim, shall be cause for the Water Authority to withhold payments to the Contractor.

(c) The Water Authority shall have full authority to compromise or otherwise settle any claim related to the Contract at any time. The Water Authority will notify the Contractor of the receipt of any third party claim.
arising from or relating to the Work within 14 days of the receipt of the claim by the Water Authority. The Water Authority shall be entitled to recover its reasonable costs incurred in providing the Contractor timely notification of third-party claims. Neither this Section nor the Water Authority’s failure to give notice shall limit the Water Authority's ability to compromise or settle any claim.

8.3 SURETIES

(a) Each surety shall be an admitted California surety and the determination of the sufficiency of the surety shall comply with California Code of Civil Procedure Section 995.660.

(b) The Contractor shall provide all bonds executed by the Contractor and the surety to the Water Authority for approval prior to execution of the Contract. Bonds shall be in the form provided in the contract documents.

(c) If the admitted surety on any bond furnished by the Contractor is declared bankrupt, or it becomes insolvent or goes into receivership, or its right to do business is terminated in the State of California, or in the opinion of the Engineer is about to become insufficient, or ceases to meet the requirements set forth in the contract documents, the Contractor shall within five days thereafter, or after receipt of written notice from the Engineer to do so, substitute another bond that meets all requirements of the contract documents, including certification that the substitute surety is an admitted surety insurer and qualified as required by paragraph (a).

8.4 ADDITIONAL INSURANCE PROVISIONS

(a) Nothing in these Sections 8.1 through 8.4 shall be construed to limit or qualify the liabilities and obligations otherwise assumed by the Contractor pursuant to this Contract, including but not limited to the provisions of Sections 9.1 through 9.3 relating to indemnity and warranty.

(b) The Water Authority may require the Contractor to provide complete copies of all insurance policies required by Section 8.1.

(c) If at any time, the Contractor fails to maintain in full force any insurance required by the Contract, the Water Authority may acquire the necessary insurance for the Contractor and deduct the cost thereof from any payment due the Contractor.
SECTION 9 INDEMNIFICATION AND WARRANTY

9.1 INDEMNIFICATION

(a) To the fullest extent permitted by law and without limitation by the provisions of Section 8 relating to insurance, the Contractor shall indemnify, defend (with independent counsel approved by the Water Authority) and hold harmless the Water Authority from and against all liabilities (including without limitation all claims, losses, damages, penalties, fines, and judgments, associated investigation and administrative expenses, and defense costs, including but not limited to reasonable attorneys’ fees, court costs and costs of alternative dispute resolution) regardless of nature, type, or cause, arising out of or resulting from or in connection with the performance of the Contract. The Contractor’s obligations under this Section apply regardless of whether or not a liability is caused or contributed to by any act or omission of the Water Authority, except that the Contractor shall not be obligated to indemnify for liability arising from the sole negligence or willful misconduct of the Water Authority. The provisions of this Section survive the completion of the Work or termination of the Contract.

(b) To the fullest extent permitted by law and without limitation by the provisions of Section 8 relating to insurance, the Contractor shall also indemnify, defend and hold harmless the Water Authority from and against all liability (including without limitation all claims, damages, penalties, fines, and judgments, associated investigation and administrative expenses, and defense costs, including but not limited to reasonable attorneys’ fees, court costs, and costs of alternative dispute resolution) resulting from any claim of discrimination or harassment, including but not limited to sexual harassment, arising from the conduct of the Contractor or any of the Contractor’s officers, employees, agents, licensees, or subcontractors. In the event of a discrimination or harassment complaint against any employee, agent, licensee or subcontractor of the Contractor or its subcontractors, the Contractor shall take immediate and appropriate action in response to such complaint, including, but not limited to termination or appropriate discipline of any responsible employee, agent, licensee or subcontractor. The provisions of this Section survive completion of the Work or termination of the Contract.

9.2 GENERAL WARRANTY

(a) Neither the Notice of Completion, nor the written acceptance of the Work, nor any provision of the contract documents, nor partial or entire occupancy of the premises by the Water Authority shall constitute an acceptance of Work not done in accordance with the contract documents or relieve the Contractor of liability in respect to any express warranties, statutory or common law responsibility for faulty materials or workmanship. The Contractor shall repair or replace any defects in the Work to the satisfaction of the Engineer and pay for any damage to others resulting from defects in the Work, which shall appear within the period of 730 days from the date of recording of the Notice of Completion at the San Diego County Recorder’s office. This warranty and warranty period shall apply to the entire Work completed under this Contract with the exception of those portions of Work occupied and used by the Water Authority pursuant to Section 7.8, in which case the warranty shall run from the time of occupancy if the occupancy is pursuant to paragraph (a) of Section 7.8, or from the time of completion of the items stated in the written statement if the occupancy is pursuant to paragraph (b) of Section 7.8.

(b) Neither the foregoing, nor any provision of the contract documents, nor any special warranty time limits, shall be held to limit the Contractor’s liability for defects to less than the legal limits of liability in accordance with the law.

(c) The Contractor shall during the period of warranty keep the surface of the ground over this Work or adjacent thereto in the position and condition required by the contract documents and refill any settlement or erosion in the backfilling or any surface graded by him, or replace or repair any improvements damaged by such settlement or erosion. Should the Contractor fail to commence or complete the refilling, replacement, or repair work, the Water Authority may have the work done and recover the costs thereof from the Contractor.
GENERAL CONDITIONS

(d) Any defect observed during the warranty period shall be presumed to be caused by defective Workmanship or materials unless the Contractor can establish that the defect was the result of other causes. Should warranty work be performed by the Contractor subsequent to 730 days following the date of recording of the Notice of Completion, the performance bond and insurance required for the warranty period shall remain in full force and effect until the warranty work has been completed and a written acceptance of the completed warranty work has been issued by the Engineer.

9.3 PRODUCT WARRANTIES

Prior to the completion of the Work, the Contractor shall obtain, assign and deliver to the Water Authority all written warranties from manufacturers, fabricators, suppliers for goods, products, equipment, machines, and other components of the Work. The duration of the warranties shall be as provided in the specifications for the good, product, equipment, machine or other component, or if not otherwise specified on year from the date of completion. The warranties under this section shall not operate to limit the Contractor’s general warranty under Section 9.2.

END OF SECTION
SECTION 10 PAYMENTS AND CONTRACT CLOSE-OUT

10.1 NO SEPARATE PAYMENT FOR ITEMS NEEDED TO ACCOMPLISH THE WORK

Except as otherwise expressly provided, no separate payment will be made to the Contractor for providing transportation, tools, and equipment, or for furnishing, building, maintaining and removing camps, construction plant, access roads, sanitary conveniences, disposal operations, water, sewer, communication, drainage or other utilities, fire protection, guards, trestles, communication systems or equipment, and temporary facilities needed for the Work, or for the medical attendance or health protection, or for watchmen or guards, or for any other service, plant, or material. The Contractor’s compensation for all activities, services, operations, facilities, persons, materials or any other things necessary or required to execute the Work in accordance with the provisions of the contract documents shall be considered as having been included in the Contract Price.

10.2 MONTHLY ESTIMATES OF WORK PROGRESS

(a) Within 30 work days after issuance of the Notice to Proceed, the Contractor will submit to the Engineer for approval a progress schedule, schedule of values and a statement of itemized rates for the hourly, daily, weekly, and monthly rates for labor and equipment to be used in the course of the work. The approved progress schedule and schedule of values will be used to assist in the estimating of the value of Work performed for payment purposes. Contractor agrees that it will not submit requests for progress payments unless the progress schedule, schedule of values and statement of itemized rates have been submitted and approved.

(b) On or within 5 days of the last day of each month, subject to Section 10.3, the Engineer will make an estimate of the amount and value of the work done by the Contractor as of the last day of the month and provide a written statement to the Contractor. Work for which unit prices are listed in the contract documents shall be estimated on the basis of the unit prices. Work for which a lump sum is stated in the contract documents shall be estimated according to the approved itemized cost breakdown or schedule of values, whichever is applicable. The written statement shall include any additions or deductions resulting from approved change orders. Items listed in Section 10.1 shall be included in progress payments estimates only if specifically authorized by the approved itemized cost breakdown or schedule of values.

10.3 PROGRESS ESTIMATES AND PAYMENTS MAY BE WITHHELD

The estimates provided for in Section 10.2 or progress payments under Section 10.4 may be withheld or reduced if the Engineer determines the Contractor has not complied with any and all provisions of the Contract or is not diligently and efficiently endeavoring to comply with the intent of the Contract.

10.4 CONTRACTOR REQUESTS FOR PROGRESS PAYMENTS

(a) The Contractor may request progress payments based on the monthly estimates prepared according to Section 10.2.

(b) Pursuant to Public Contract Code Section 20104.50, each request for a progress payment shall be reviewed by the Water Authority as soon as practicable after receipt for the purpose of determining that the payment request is a proper payment request. Any payment request determined not to be a proper payment request suitable for payment shall be returned to the contractor as soon as practicable, but not later than 7 days after receipt. The returned request shall be accompanied by a document setting forth in writing the reasons why the payment request is not proper.

(c) Progress payments shall not be construed as or constitute an acceptance of any portion of the Work or a waiver or release of any of the Contractor’s obligations under the Contract.
(d) A deduction of 10 percent will be made and held as retention from each progress payment; however, at any time after 50 percent of the Work has been satisfactorily completed, the Contractor may request in writing to the Engineer that the remaining progress payments be made in full. The request should include a revised construction schedule indicating that satisfactory progress is being made towards completion of the Work. If the Engineer determines the request is properly made and satisfactory progress is being made, the Engineer, at the Engineer’s sole discretion, may make any future progress payment in full. Should the Contractor fail to maintain satisfactory progress, the Engineer, at the Engineer’s sole discretion, may resume deductions from progress payments. It is the intent of this paragraph that the retention shall not exceed 10 percent of the total estimated value of the Work. The retention withheld pursuant to this paragraph is additional to any other deduction, offset or withholding that may be authorized by another provision of the contract documents or applicable laws or regulations.

(e) Unless otherwise specifically provided in the contract documents, progress payments will not be made for materials not incorporated in the Work. Progress payments may include payment for materials that will remain permanent features of the Work, not incorporated in the Work but delivered and suitably stored at the site or at another location approved by the Engineer. Payment for stored materials will be based upon a cost breakdown of the material, less the value of installation of such materials, provided, however, payment requests for stored material of less than $5000 value shall not be submitted. The Contractor shall submit a bill of sale, invoice, or other documentation warranting that the Contractor has received the materials free and clear of liens, charges, security interests, and encumbrances and evidence that the materials and equipment are covered by appropriate property insurance.

(f) If the Water Authority fails to make a progress payment within 30 days after certification of an undisputed and properly prepared payment request, the Water Authority shall pay interest to the Contractor equivalent to the legal rate set forth in subdivision (a) of Section 685.010 of the Code of Civil Procedure. The number of days available to the Water Authority for making a progress payment without incurring interest pursuant to this section shall be reduced by the number of days by which the Water Authority exceeds the seven day notice requirement set forth in subsection (a) above.

10.5 FALSE OR ERRONEOUS CERTIFICATES

The Water Authority shall not, by reason of any payment made or certified by the Engineer, or any other officer, employee or agent of the Water Authority under any provisions of the Contract, be precluded or estopped challenging the true and correct amount and character of the Work done and materials furnished, or from showing at any time that a claim for payment was false or erroneous in whole or in part, or that any of the Work does not conform to the contract documents. No progress or final payment to the Contractor shall operate as a waiver or release of any claim by the Water Authority arising from the Contractor’s failure to comply with any of the Contractor’s obligations under the contract documents.

10.6 PAYMENT ONLY IN ACCORDANCE WITH CONTRACT

The Contractor shall not demand or be entitled to receive payment for Work except in the manner set forth in the contract documents.

10.7 MONIES MAY BE RETAINED

The Water Authority may withhold any monies which would otherwise be payable at any time hereunder, and apply the same or so much as may be necessary therefore, to the payment of any expenses, losses, or damages, as determined by the Engineer, incurred by the Water Authority, for which the Contractor is liable under the Contract.
10.8 TAXES

The Contractor shall pay all applicable federal, state, and local excise, sales, consumer use, and other similar taxes required by law for the execution of the Work.

10.9 SECURITIES FOR WITHHELD PAYMENTS

Pursuant to the Public Contract Code of the State of California, the Contractor may request the Water Authority to make retention payments directly to an escrow agent or may substitute securities for any money withheld by the Water Authority to ensure performance under the Contract. At the request and expense of Contractor, securities equivalent to the amount withheld may be deposited with a state or federally chartered bank, mutually agreed upon by the Water Authority and Contractor, as the escrow agent, who shall return such securities to the Contractor upon satisfactory completion of the Contract and written notice from the Engineer to release securities. Deposit of securities with an escrow agent shall be subject to a separate written contract between the Contractor, the escrow agent, and the Water Authority, on a form provided by the Water Authority, substantially similar to the form set forth in the Public Contract Code. Securities, if deposited by the Contractor, shall be valued by the Engineer, whose decision on valuation of the securities shall be final. Only securities eligible for investment under the Water Authority’s adopted investment policy are eligible for substitution under this section.

10.10 FINAL PAYMENT

(a) On the expiration of 60 days after the date of acceptance of the Work by the Board of Directors, or on request by the Contractor for payment on an earlier date as required by Public Contract Code Section 7107, the Water Authority shall pay to the Contractor the undisputed balance of the Contract Price, including retention amounts.

(b) The Water Authority may withhold from the payment made pursuant to paragraph (a) an amount not to exceed 150 percent of any disputed amount except as provided in Section 10.11 relating to Stop Notices.

10.11 STOP NOTICES

(a) For each properly filed and unreleased stop notice, the Water Authority shall withhold from any payment 125 percent of each stop notice amount.

(b) Upon request by the Contractor, payments may be made jointly to the Contractor and a stop notice claimant. Any such payment shall be deemed to be a payment to the Contractor.

10.12 NO PAYMENTS EXCEPT UPON WAIVER AND RELEASE OF CLAIMS.

No payment, whether progress or final, shall be made except upon receipt by the Water Authority of a waiver and release of claims, in accordance with Civil Code Section 3262, executed and delivered by the Contractor and any joint payee of the Contractor.

10.13 RIGHT TO AUDIT

The Water Authority shall have the right to audit, during the Contractor’s normal business hours at the office of the Contractor, any of the Contractor’s books and records to the extent they are relevant or calculated to lead to relevant evidence relating to any claim submitted by the Contractor or the Contractor’s performance under the Contract. This right shall include, without limitation, the right to examine the books, records, documents, bid records, and other evidence and accounting procedures and practices, sufficient to discover and verify all direct and indirect costs, including claimed unabsorbed overhead costs of whatever nature claimed to have been incurred or anticipated to be incurred and for which the claim has been submitted. The Contractor further agrees that the right to audit encompasses all subcontracts and is binding upon subcontractors. Additionally, the Contractor shall...
make available within 10 days to the Engineer for auditing, all requested schedules, Plans, accounting records and documents, and other financial data, and upon request, shall submit true copies of requested records to the Engineer.

10.14 ASSIGNMENT OF ANTI-TRUST CLAIMS

The Contractor agrees to assign to the Water Authority 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. Sec. 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. This assignment shall become effective at the time the Water Authority tenders final payment to Contractor, without further acknowledgment by the parties. The Contractor shall have the rights set forth in Section 4553 and 4554 of the Government Code.

10.15 ASSIGNMENT OF LICENSES

As a condition of completion of the Work, the Contractor shall assign to the Water Authority all software and other licenses for use of intellectual property, if any, incorporated into the Work.

END OF GENERAL CONDITIONS
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section describes the responsibilities for the survey of the work.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Standard Specifications for Public Works Construction.

1.03 SUBMITTALS

A. Surveyor Qualifications.

B. Calculations, field notes, and mapping used to develop site control, facility layout, and setting of survey monuments. Provide computer files of all survey data, compatible with the latest version of AutoCAD, tied to benchmark elevation and coordinates shown on the Plans.

PART 2 – MATERIALS

2.01 SURVEY MONUMENTS

A. Survey monuments shall be three inch diameter, domed type, die-cast from solid brass, with two-inch ribbed shank.

PART 3 - EXECUTION

3.01 SURVEY CONTROL

A. Surveying for the work shall be provided in accordance with Section 2-9, Surveying, of the SSPWC, except as modified herein.

B. The Contractor shall be responsible for construction surveying, including quantity surveys. Establish and tie survey control to the work shown on the Plans. Check the positions of the various points comprising the primary control, and notify the Engineer in writing within 60 calendar days of the Notice to Proceed of discrepancies found between actual and record measurements. The Engineer reserves the right to conduct check surveys to confirm quantities.

C. The Engineer may check all lines, elevation, reference marks, etc., set by the Contractor, and the Contractor shall correct any errors disclosed by such check. Such a check shall not be considered an approval of the Contractor's work and shall not relieve the Contractor of the responsibility for accurate construction of the entire work.

D. For tunnels, two offset reference stakes for line and grade will be provided at each tunnel portal. The exact location of these benchmarks and monuments will be dictated by conditions at the site.

E. Preserve existing property line and corner survey monuments encountered along the route of the work. Where existing monuments conflict with the Contractor's construction operations and destruction of monuments are unavoidable, provide written notification to the Engineer and the owner of the monument prior to the removal or destruction of said monument. Retain a State of California registered Civil Engineer or Registered Land Surveyor to install new monuments and replace monuments that are removed or destroyed. Replace monuments within 30 days following the completion of construction operations that necessitated the removal or destruction of the monument.
F. Immediately following clearing and grubbing, perform representative cross-sections the width of the right-of-way at 100 foot maximum spacing, with intermediate shots at all existing pipelines. Provide this survey information to the Engineer prior to excavation. Use these cross-sections for restoration of the right-of-way.

G. Install three-inch diameter survey monuments on the exterior roof surface of manway, air vacuum/air release valve, blowoff valve and pump well structures. Attach monuments at the locations shown on the Plans by applying epoxy adhesive to the shank and imbedding monument flush with the concrete surface. Center punch the monument with point and point number provided by the Engineer. Prepare, record, and pay all fees associated with filing a Record of Survey for new survey monuments.

END OF SECTION
PART I - GENERAL

1.01 ABBREVIATION USAGE IN SPECIFICATIONS DOCUMENT

A. Wherever in these Specifications references are made to the Standards, Specifications, or other published data of the various international, national, regional, or local organizations, such organizations may be referred to by their acronym or abbreviation only. As a guide to the user of these Specifications, the following acronyms or abbreviations which may appear in these Specifications shall have the meanings indicated herein.

1.02 ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AAMA</td>
<td>Architectural Aluminum Manufacturer's Association</td>
</tr>
<tr>
<td>AASHTO</td>
<td>American Association of State Highway and Transportation Officials</td>
</tr>
<tr>
<td>ACI</td>
<td>American Concrete Institute</td>
</tr>
<tr>
<td>AFBMA</td>
<td>Anti-Friction Bearing Manufacturer's Association, Inc.</td>
</tr>
<tr>
<td>AGA</td>
<td>American Gas Association</td>
</tr>
<tr>
<td>AGC</td>
<td>Associated General Contractors of America</td>
</tr>
<tr>
<td>AGMA</td>
<td>American Gear Manufacturers Association</td>
</tr>
<tr>
<td>AI</td>
<td>The Asphalt Institute</td>
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<tr>
<td>AIA</td>
<td>American Institute of Architects</td>
</tr>
<tr>
<td>AIEE</td>
<td>American Institute of Electrical Engineers</td>
</tr>
<tr>
<td>AISC</td>
<td>American Institute of Steel Construction</td>
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<tr>
<td>AISI</td>
<td>American Iron and Steel Institute</td>
</tr>
<tr>
<td>AMCA</td>
<td>Air Moving and Conditioning Association</td>
</tr>
<tr>
<td>ANS</td>
<td>American Nuclear Society</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute, Inc.</td>
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<tr>
<td>APA</td>
<td>American Plywood Association</td>
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<tr>
<td>API</td>
<td>American Petroleum Institute</td>
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<tr>
<td>APWA</td>
<td>American Public Works Association</td>
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<td>AREA</td>
<td>American Railway Engineering Association</td>
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<tr>
<td>ASA</td>
<td>Acoustical Society of America</td>
</tr>
<tr>
<td>ASCE</td>
<td>American Society of Civil Engineers</td>
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<tr>
<td>ASHRAE</td>
<td>American Society of Heating, Refrigerating, and Air Conditioning Engineers</td>
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<tr>
<td>ASLE</td>
<td>American Society of Lubricating Engineers</td>
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<tr>
<td>ASME</td>
<td>American Society of Mechanical Engineers</td>
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<tr>
<td>ASQC</td>
<td>American Society for Quality Control</td>
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<tr>
<td>ASSE</td>
<td>American Society of Sanitary Engineers</td>
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<td>ASTM</td>
<td>American Society for Testing and Materials</td>
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<td>AWG</td>
<td>American Wire Gauge</td>
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<td>AWS</td>
<td>American Welding Society</td>
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<tr>
<td>AWWA</td>
<td>American Water Works Association</td>
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<tr>
<td>BBC</td>
<td>Basic Building Code, Building Officials and Code Administrators International</td>
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<tr>
<td>BHMA</td>
<td>Builders Hardware Manufacturer's Association</td>
</tr>
<tr>
<td>CALTRANS</td>
<td>California Department of Transportation</td>
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<td>CALOSHA</td>
<td>California Occupational Safety and Health Administration</td>
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<tr>
<td>CBM</td>
<td>Certified Ballast Manufacturers</td>
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<tr>
<td>CDA</td>
<td>Copper Development Association</td>
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<tr>
<td>CE</td>
<td>Carbon Equivalent</td>
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<tr>
<td>CEMA</td>
<td>Conveyors Equipment Manufacturer's Association</td>
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<td>CGA</td>
<td>Compressed Gas Association</td>
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<tr>
<td>CEQA</td>
<td>California Environmental Quality Act</td>
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<tr>
<td>CLPCA</td>
<td>California Lathing and Plastering Contractors Association</td>
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<tr>
<td>CLFMI</td>
<td>Chain Link Fence Manufacturer's Institute</td>
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<tr>
<td>CMA</td>
<td>Concrete Masonry Association</td>
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<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<tr>
<td>CPM</td>
<td>Critical Path Method</td>
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<tr>
<td>CPVC</td>
<td>Chlorinated Polyvinyl Chloride</td>
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<tr>
<td>CRSI</td>
<td>Concrete Reinforcing Steel Institute</td>
</tr>
<tr>
<td>CWI</td>
<td>Certified Welding Inspector</td>
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<tr>
<td>DEVO</td>
<td>Diverse Emerging Vendor Outreach</td>
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<tr>
<td>EIA</td>
<td>Electronic Industries Association</td>
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<tr>
<td>ETL</td>
<td>Electrical Test Laboratories</td>
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<tr>
<td>EPA</td>
<td>Environmental Protection Agency</td>
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<tr>
<td>EPR</td>
<td>Ethylene Propylene Rubber</td>
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<tr>
<td>EST</td>
<td>Edwards Systems Technologies.</td>
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<tr>
<td>FCAW-G</td>
<td>Flux Cored Arc Weld-Gas Shield</td>
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<td>FM</td>
<td>Factory Mutual System</td>
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<tr>
<td>FOTP</td>
<td>Fiber Optics Test Procedures</td>
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<tr>
<td>FRP</td>
<td>Fiberglass Reinforced Plastic</td>
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<td>GDSR</td>
<td>Geotechnical Design Summary Report</td>
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<tr>
<td>HDA</td>
<td>Hand-Off Automatic</td>
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<tr>
<td>HGL</td>
<td>Hydraulic Grade Lin</td>
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<tr>
<td>HI</td>
<td>Hydronics Institute</td>
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<tr>
<td>HMI</td>
<td>Human Machine Interface</td>
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<tr>
<td>HPDE</td>
<td>High Density Polyethylene</td>
</tr>
<tr>
<td>HVAC</td>
<td>Heating Venting Air Conditioning</td>
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<tr>
<td>IAPMO</td>
<td>International Association of Plumbing and Mechanical Officials</td>
</tr>
<tr>
<td>ICBO</td>
<td>International Conference of Building Officials</td>
</tr>
<tr>
<td>ICS</td>
<td>Industrial Control Systems</td>
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<tr>
<td>ID</td>
<td>Internal Diameter</td>
</tr>
<tr>
<td>IDC</td>
<td>Initiating Device Circuits</td>
</tr>
<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers</td>
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<td>IES</td>
<td>Illuminating Engineering Society</td>
</tr>
<tr>
<td>IME</td>
<td>Institute of Makers of Explosives</td>
</tr>
<tr>
<td>I/O</td>
<td>Input and Output</td>
</tr>
<tr>
<td>IPC</td>
<td>Institute of Printed Circuits</td>
</tr>
<tr>
<td>IPCEA</td>
<td>Insulated Power Cable Engineers Association</td>
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<tr>
<td>IRS</td>
<td>Internal Revenue Service</td>
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<td>ISA</td>
<td>Instrument Society of America</td>
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<td>ISO</td>
<td>International Organization for Standardization</td>
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<tr>
<td>ITE</td>
<td>Institute of Traffic Engineers</td>
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<tr>
<td>IWC</td>
<td>Inches of Water Column</td>
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<tr>
<td>MDPE</td>
<td>Medium Density Polyethylene</td>
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<tr>
<td>M&amp;IE</td>
<td>Meals and Incidental Expenses</td>
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<td>MIG</td>
<td>Gas Metal Arc</td>
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<td>MPTA</td>
<td>Mechanical Power Transmission Association</td>
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<td>MSS</td>
<td>Manufacturers Standardization Society</td>
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<td>NAAMM</td>
<td>National Association of Architectural Metal Manufacturer's</td>
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<td>NAC</td>
<td>Notification Appliance Circuit</td>
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<td>NACE</td>
<td>National Association of Corrosion Engineers</td>
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<td>NBFU</td>
<td>National Bureau of Fire Underwriters</td>
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<td>NBS</td>
<td>National Bureau of Standards</td>
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<td>N/C</td>
<td>Normally Closed</td>
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<td>NCCLS</td>
<td>National Committee for Clinical Laboratory Standards</td>
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<td>NEC</td>
<td>National Electrical Code</td>
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<td>National Electrical Manufacturer's Association</td>
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<td>NETA</td>
<td>National Electrical Testing Association</td>
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<td>NFPA</td>
<td>National Fire Protection Association</td>
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<tr>
<td>NLGI</td>
<td>National Lubricating Grease Institute</td>
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<td>NOI</td>
<td>Notice of Intent</td>
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<tr>
<td>NOT</td>
<td>Notice of Termination</td>
</tr>
<tr>
<td>NPDES</td>
<td>National Pollution Discharge Elimination System</td>
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</table>
NSF  National Sanitation Foundation
OSHA  Occupational Safety and Health Administration
OTDR  Optical Time Domain Reflectometer
PCA  Portland Cement Association
PLC  Programmable Logic Controller
PPI  Plastics Pipe Institute
PVC  Polyvinyl-Chloride
QC  Quality Control
RCRA  Resource Conservation and Recovery Act
RPI  Requested Packet Interval
RTU  Remote Terminal Unit
RWMA  Resistance Welder Manufacturer's Association
RWQCB  Regional Water Quality Control Board
SAE  Society of Automotive Engineers
SCOOP  Small Contractor Outreach and Opportunities Plan
SDRSD  San Diego Area Regional Standard Drawings
SMA  Screen Manufacturers Association
SMACCNA  Sheet Metal and Air Conditioning Contractors National Association
SMAW  Shielded Metal Arc Weld
SPDT  Single Pole Double Throw
SPI  Society of the Plastics Industry, Inc.
SPR  Simplified Practice Recommendation
SSBC  Southern Standard Building Code, Southern Building Code Congress
SSPC  Steel Structures Painting Council
SSPWC  Standard Specifications for Public Works Construction
SWPPP  Storm Water Pollution Prevention Program
TBM  Tunnel Boring Machine
TFI  The Fertilizer Institute
THWN  Thermoplastic Heat and Water Resistant
TIG  Gas Tungsten Arc
UBC  Uniform Building Code
U/L or UL  Underwriters Laboratories, Inc.
UPC  Unified Certification Program
UPS  Uninterruptible Power Supply
USGS  United States Geological Survey
VOC  Volatile Organic Compound
WCRSI  Western Concrete Reinforcing Steel Institute
WEF  Water Environment Federation
WPS  Welding Procedure Specification
WRI  Wire Reinforcement Institute, Inc.

PART 2 - MATERIALS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section describes the requirements for preparing and submitting submittals. Submittals include Shop Drawings, samples, Progress Schedules, Cost Schedules, Daily Reports, Record Drawings, Spare Part List, Operations and Maintenance Manuals, copies of Permits and other items as required by the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01310 Progress Schedules
B. Section 01370 Schedule of Values

1.03 GENERAL REQUIREMENTS

A. Within 15 days of the date of receipt of the Notice to Proceed, deliver to the Engineer a preliminary schedule of submittals in a form satisfactory to the Engineer showing the content and proposed dates for delivery of submittals as required herein. All submittals and samples shall become the property of the Water Authority.

B. All submittals shall clearly identify the item(s) by Specification Section and Plan sheet number, and include references to applicable standards and codes.

C. Submittals shall be complete in all respects. If the submittals show any deviations from the requirements of the Contract Documents, the deviations and the reasons therefor shall be set forth in the Letter of Transmittal.

D. By submitting the submittals, the Contractor represents that the material, equipment, and other work shown thereon conforms to the Contract Documents, except for the deviations set forth in the Letter of Transmittal.

E. Submittal review by the Engineer is only for general compliance with the design concept of the project and general compliance with the Contract Documents, and shall not be construed as relieving the Contractor of the full responsibility for: providing materials, equipment, and work required by the Contract Documents; the proper fitting and construction of the work; the accuracy and completeness of the submittals; selecting fabrication processes and techniques of construction; and performing the work in a safe and orderly manner.

F. Do not commence any portion of the work requiring a submittal until all the submittals and all other dimensions, quantities and materials pertinent to that portion of the work have been reviewed by the Engineer and returned to the Contractor with the notation indicating that resubmittal is not required.

G. For any submittal requiring more than two submittals (original submittal plus one resubmittal) to obtain the approval of the Engineer, the Water Authority shall withhold monies from each progress payment to cover all costs incurred by the Water Authority to review and process any resubmittals subsequent to the second submittal.

1.04 CONTRACTOR'S SCHEDULE AND COST REPORTS

A. Prepare and submit construction schedules and reports in accordance with the provisions of Section 01310, Progress Schedules. Cost components of the work corresponding to the lump sum bid items shall be submitted in accordance with Section 01370, Schedule of Values.

B. Within 30 days of the date of receipt of the Notice to Proceed, submit a statement of itemized rates for the hourly, daily, weekly, and monthly rates for labor and equipment to be used in the course of the work.
1.05 SHOP DRAWINGS

A. The term "Shop Drawings" as used herein shall be understood to include: Detail Design Calculations, Shop Drawings, Fabrication, and Installation Drawings, Erection Drawings, lists, graphs, operating instructions, Catalog Sheets, Data Sheets, and similar items.

B. Review, stamp with approval, and submit for review by the Engineer, Shop Drawing submittals as called for in the Contract Documents, or as requested by the Engineer. Submit each Shop Drawing submittal in sextuplet (six copies) to the Engineer and transmit with a letter of transmittal listing the Shop Drawing submitted. Indicate on each Shop Drawing submittal the name of the project, the name of the Contractor, and if any, the names of the suppliers, manufacturers, and subcontractors. Submit Shop Drawing submittals in an orderly sequence, so as to cause no delay in the prosecution of the work.

C. Provide on each Shop Drawing submittal the following Certification Statement, signed by the Contractor:

"Certification Statement: By this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data and I have checked and coordinated each item with other applicable submittals and other requirements of the contract documents."

D. Use a separate transmittal form for each specific item or class of material or equipment for which a submittal is required. Transmittal of a submittal of various items using a single transmittal form will be permitted only when the items taken together constitute a manufacturer's "package" or are functionally related.

E. Assign each submittal a unique number. Clearly note the submittal numbers on the transmittal. Number each submittal with the identifying specification section, followed by a sequential number that represents the Contractor's assigned number of 01, 02, et cetera. Resubmittals shall be numbered by adding a dot (.) and 01, 02, 03, et cetera to the original submittal number, depending on the number of times the submittal has been resubmitted. For example: if Submittal 03300-01 requires a resubmittal, the first resubmittal will bear the designation “03300-01.01” and the second resubmittal will bear the designation “03300-01.02” and so on.

F. If two copies of a submittal are returned to the Contractor marked RESUBMITTAL IS NOT REQUIRED. CORRECTIONS, IF ANY, ARE NOTED. Formal revision and resubmission of said submittal will not be required.

G. If two copies of a submittal are returned to the Contractor marked PLEASE CORRECT AND RESUBMIT, revise said submittal and resubmit the revised submittal to the Engineer.

H. Fabrication of an item may be commenced only after the Engineer has reviewed the pertinent submittals and returned copies to the Contractor marked RESUBMITTAL IS NOT REQUIRED. CORRECTIONS, IF ANY, ARE NOTED. Corrections indicated on submittals shall be considered as changes necessary to meet the requirements of the Contract Documents.

I. As soon as practicable after approval by the Engineer of any Shop, Assembly, or Layout Drawing, forward to the Engineer one clear, legible, transparent mylar of the tracing of the approved drawing; except that a clear, legible, sepia transparency of each final corrected sheet for bending diagrams, placing lists, and placing drawings for reinforcement steel will be acceptable.

1.06 SAMPLES

A. Whenever samples are required, submit not less than three samples of each such item or material to the Engineer.

B. Submit samples for acceptance a minimum of 21 days prior to ordering such material for delivery to the jobsite. Submit samples in an orderly sequence so that dependent materials or equipment can be assembled and reviewed without causing delays in the work.
C. Label or tag all samples individually and indelibly indicate thereon all specified physical characteristics and manufacturer's name for identification, and submit to the Engineer for acceptance. Upon receiving acceptance of the Engineer, one set of the samples will be stamped and dated by the Engineer and returned to the Contractor, one set of samples will be retained by the Engineer, and one set of samples will remain at the job site until completion of the work.

D. All colors and textures of specified items will be selected by the Engineer from the manufacturer's standard colors and standard materials, products, or equipment lines.

1.07 DAILY REPORTS

A. Provide for each work shift a written Daily Report to the Engineer describing the work performed, conditions encountered, weather conditions, delays to the work, accidents or safety concerns, and any construction problems or deviations from the requirements of the Contract Documents. Show on the Daily Report an itemized breakdown of all labor, material deliveries, equipment, and subcontract labor used in performing the work. Submit the Daily Report within two days after completion of the reported work shift.

1.08 PERMITS

A. Obtain all permits and licenses necessary to the prosecution of the work. Submit a copy of all permits and licenses to the Engineer within 30 days of issuance.

B. The Contractor and all his subcontractors, vendors and service providers shall comply with the regulations as stated in each permit for the applicable portion of the work governed by the respective permit. Failure by the Contractor, its subcontractors, vendors and service providers to comply with any permit requirements may cause monetary fines or other such retribution against the Water Authority by the permit-granting agency. Permit fines or other such retribution against the Water Authority that result from the acts or negligence of the Contractor, its subcontractors, vendors and service providers shall be paid for by the Contractor by deducting from the monies due the Contractor under this Contract.

1.09 SPARE PARTS LIST

A. Furnish to the Engineer five identical sets of spare parts information for all mechanical, electrical, and instrumentation equipment. Limit the spare parts list to those spare parts, which each manufacturer recommends be maintained by the Water Authority in inventory. Include on the Spare Parts List the current list price of each spare part. Indicate the name, address, telephone number, and email address of the nearest outlet of each manufacturer or supplier of spare parts to facilitate the Water Authority in ordering. Cross-reference all spare parts to the equipment numbers designated in the Contract Documents.

1.10 RECORD DRAWINGS

A. Prepare and maintain as the work progresses Record Documents for the project to accurately reflect all aspects of the work constructed as built. The completed Record Documents shall be submitted to and approved by the Engineer prior to acceptance of the work.

B. Store Record Documents in an approved location apart from documents used for construction. Do not use Record Documents for construction purposes. Maintain Record Documents in a clean, dry, legible condition and make documents and samples available at all times for inspection by the Engineer. Label each document PROJECT RECORD in neat, large, printed letters.

C. Mark all changes using a red pencil or red pen on full size drawings. Do not permanently conceal any work until required information has been recorded. Record and make permanent record of the following:

1. Horizontal and vertical location of structures, improvements, finished ground elevations, underground utilities and appurtenances thereto, referenced to benchmark elevations and permanent surface improvements.
2. Field changes of dimension and detail.

3. Changes made by Contract Change Order or Field Order.

4. Details not on original contract Plans or submittals.

D. Submit Record Documents for acceptance by the Engineer as a precondition for each monthly progress payment to be made to the Contractor. The Record Plans shall be up-to-date through the end of the applicable progress payment period.

E. Deliver the completed Record Documents to the Engineer. Provide a transmittal letter containing:

1. Project Title and Specification number.
2. Contractor's name and address.
3. Title and number of each Record Document.
4. Certification that each document as submitted is complete and accurate.
5. Signature of Contractor.

PART 2 - MATERIALS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section describes the scheduling of work requirements to be performed by the Contractor. The development of the schedule, monthly payment requisitions, and project status reporting requirements of the Contract shall employ computerized Critical Path Method scheduling. Prepare the CPM Schedule and all reports with the latest version of “Primavera,” or equal software.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300 Submittals

B. Section 01370 Schedule of Values

1.03 QUALIFICATIONS

A. Submit to the Engineer a statement of computerized CPM qualifications verifying the Contractor's in-house staff or consultant capability to use CPM techniques required herein. Identify the individual who will perform the CPM scheduling and verify qualifications by providing a description of construction projects that the individual has successfully applied computerized CPM. List at least two projects of similar nature, scope, and value, and provide a contact person for each referenced project with current telephone, fax, email address, and mailing address information.

1.04 CPM STANDARDS

A. CPM, as required herein, shall be interpreted to be generally as outlined in the Association of General Contractors publication, “The Use of CPM in Construction,” except that either “i-j” arrow diagrams or precedence diagramming format may be utilized. In the case of conflicts between this specification and the AGC publication, this specification shall govern.

B. Include with construction schedules a graphic network diagram and computerized construction schedule reports.

C. The CPM network shall be in a form of a time scaled “i-j” activity-on-arrow or precedence type diagram and may be divided into a number of separate sheets with suitable match lines relating the interface points among the sheets.

D. Indicate all construction activities and procurement in a time-scaled format using a calendar time line shown along the entire sheet length. Plot each activity arrow or node so that the beginning and completion dates of each activity are accurately represented along the calendar time line. Show all activities using the symbols that clearly distinguish between Critical Path activities, non-critical activities, and free float for each non-critical activity. Identify all activity items by their respective Activity Number, Responsibility Code, Work Duration, and their Dollar Value. All non-critical path activities shall show their total float time in scale form by utilizing a dotted line or some other graphical means.

E. Compute the duration estimate indicated for each activity in working days and represent the single best estimate considering the scope of the activity work and resources planned for the activity.

F. Except where otherwise provided herein, float as referenced in these documents is total float. Total float is the period of time measured by the number of working days each non-critical path activity may be delayed before it and its succeeding activities become part of the Critical Path. If a non-critical path activity is delayed beyond its float period, that activity then becomes part of the Critical Path and controls the end date of the Project. Thus, the delay of the non-critical path activity beyond its float period will cause delay to the Project itself.
G. Neither the Water Authority nor the Contractor owns the float time. The Project owns the float time. As such, liability for delay of the project completion date rests with the party actually causing delay to the Project completion date. For example, if Party A uses some, but not all of the float time and Party B later uses the remainder of the float time as well as additional time beyond the float time, Party B shall be liable for the costs associated with the time that represents a delay to the Project's completion date. Party A would not be responsible for any costs since it did not consume all of the float time and additional float time remained; therefore, the Project's completion date was unaffected.

1.05 CPM SCHEDULE SUBMITTALS

A. Within 30 calendar days after the date of receipt of the Notice to Proceed, submit for review by the Engineer one hard copy and one compact disc (CD-R format) of the initial CPM Network Schedule and the Computerized Schedule Report tabulation. The CPM Schedule shall be a time-scaled network diagram of the "i-j" activity-on-arrow or precedence type. The network diagram shall describe the activities to be accomplished and their logical relationships, and show the Critical Path.

B. The computerized schedule report tabulations shall include the following:

1. Report of activities sorted by Activity Number. Correlate Activity Numbers, where practical, to the Contractor's work areas.

2. Report of activities sorted by Early Start date.


4. Report of activities sorted by Responsibility Code. Responsibility Codes shall be established for the Contractor, Engineer, Water Authority, subcontractors, suppliers, etc. Codes shall be identified in the Network Diagram.

5. A Successor-Predecessor Report which shall identify the successor and predecessor activities for each activity and ties between schedule activities.

C. Include sufficient detail for the identification of work components into such activities as mobilization and demobilization; clearing and grubbing; temporary erosion control installation and removal; traffic control; dewatering; shoring and bracing installation and removal; trenching, backfilling and compaction; blasting; tunneling; final grading; restoration and revegetation; pavement repair; pipe fabrication; pipe installation; pipe lining; coating of field joints; installing valves and miscellaneous piping; testing and disinfection; placing reinforcement; forming, placing and curing of concrete; masonry construction; miscellaneous metals fabrication and installation; painting and coating; installation of electrical and instrumentation equipment; and other such work.

D. Within 15 calendar days after submittal of initial CPM Network Schedule, meet with the Engineer to review such submittal. The Engineer's review will be limited to the submittal's conformance to the Contract requirements, and may include directions to include activities and information missing from the submittal and requests to the Contractor to clarify his schedule.

E. Revise the initial CPM Network Schedule submittal to address all review comments received from the Engineer and resubmit the Network Diagrams and reports. The Engineer will either (1) accept the resubmitted schedule, or (2) advise the Contractor in writing to review any part or parts of the schedule, which either do not meet the Contract requirements or are unsatisfactory for the Engineer to monitor the project's progress and status. The Engineer may accept the schedule with conditions that the first monthly CPM Schedule update be revised to correct deficiencies identified. When the CPM Schedule is accepted, it shall be considered as the "Baseline CPM Construction Schedule." The Water Authority reserves the right to require that the Contractor adjust, add to, or clarify any portion of the CPM Schedule, which may later be discovered to be insufficient for the monitoring of the work.
F. Acceptance of the Baseline CPM Construction Schedule by the Engineer shall be a CONDITION PRECEDENT to holding the Pre-Construction Conference, mobilizing any labor, equipment and materials at the site of work, and processing any Application for Payment subsequent to the first monthly payment.

G. By way of the Contractor assigning activity durations and proposing the sequence of the work, the Contractor agrees to utilize sufficient and necessary management and other resources to perform the work in accordance with the CPM Schedule.

H. Submission of the Baseline CPM Construction Schedule to Engineer shall not relieve the Contractor of his total responsibility for scheduling, sequencing, and pursuing the work to comply with the requirements of the Contract Documents, including adverse effects such as delays resulting from ill-timed work.

I. Following the acceptance of the Contractor's Baseline CPM Construction Schedule, monitor the progress of the work and adjust the Schedule each month to reflect actual progress and any changes in planned future activities. Submit each CPM Schedule monthly update to meet all requirements as indicated herein for the original schedule submittal. Show all work activities on each update, including those already completed. Accurately show the "record" information for completed work activities by indicating when the work was actually started and completed.

J. The CPM Schedule update submittal will be reviewed with the Contractor during monthly construction progress meetings. Subsequent to such meetings, submit on or before the fifth day of each month a revised CPM Network Diagram, revised CPM computerized tabulations, and revised Successor-Predecessor Report. Acceptance of the monthly Schedule Update submittal shall be a condition precedent to processing each monthly application for payment.

K. Highlight or otherwise identify all changes to the Schedule. Modify any portions of the CPM Schedule, which become infeasible because of activities behind schedule or for any other valid reason.

L. Neither the submission nor the updating of the Contractor's Schedule submittal, nor the Engineer's review or acceptance of any such Schedule shall have the effect of modifying the Contract completion date or milestone dates or the Contractor's obligations under this Contract.

1.06 CHANGE ORDERS

A. Incorporate approved Change Orders in the Schedule Update submittal for the next month following Change Order approval. Utilize a sub-network in the schedule depicting the changed work and its effect on other activities. Tie this subnetwork to the main network with the appropriate logic so that a true analysis of the Critical Path can be made.

1.07 SCHEDULE REPORTS (FORMAT)

A. Prepare Schedule Reports based on the Construction Schedule, and include the following minimum data for each activity:

1. Activity Numbers and Responsibility Codes.
2. Work Order Number.
3. Estimated Activity Duration.
4. Activity Description.
5. Activity's Percent Completion.
6. Early Start Date (Calendar Dated).
7. Early Finish Date (Calendar Dated).
8. Late Start Date (Calendar Dated).
9. Late Finish Date (Calendar Dated).
10. Status (Whether Critical).
11. Total Float for Each Activity.

B. Preface each Schedule Report with the following summary data:
   1. Project Name.
   2. Contractor.
   3. Type of Tabulation.
   4. Project Duration.
   5. Contract Completion Date (revised to reflect time extensions).
   6. The Commencement Date stated in the Notice to Proceed.
   7. The Data Date and Plot Date of the Network Diagram.
   8. If an update, cite the new schedule completion date.

1.08 INCLEMENT WEATHER DELAYS

A. Include days lost on the CPM’s Critical Path due to inclement weather. Inclement weather days shall be determined as provided in Section 7.1 of the General Conditions.

1.09 PAYMENT WITHHOLDINGS

A. If any submittal required by this Section is determined by the Engineer to be incomplete or is submitted after the required submittal date, the Water Authority may withhold payments to the Contractor in accordance with Section 10.3 of the General Conditions.

PART 2 - MATERIALS (NOT USED)

PART 3 - EXECUTION (NOT USED)
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section describes the process whereby the Schedule of Values is developed and used to determine monthly progress payment amounts.

B. Develop the Schedule of Values independent but simultaneous with the development of the CPM Schedule activities and logic as specified herein.

C. Ensure that the values indicated in the Schedule of Values are equal to the corresponding values named in the Bidding Sheet.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300 Submittals

B. Section 01310 Progress Schedules

C. Section 01505 Mobilization

1.03 PRELIMINARY SCHEDULE OF VALUES

A. Within 30 calendar days after the date of receipt of the Notice to Proceed, submit a Preliminary Schedule of Values for the major components of work showing, at a minimum, the proposed total value for each of the separately listed work component applicable to the work, as follows:

1. Mobilization, including initial mobilization of Contractor’s plant, equipment and personnel; demobilization and remobilization due to construction shutdown; permits, insurance, and bonds; CPM Construction Schedule and Schedule of Values; temporary utilities; Contractor’s field office; potholing for existing utilities; demobilization and cleanup; site maintenance; and photographic documentation.

2. Sheet, shoring and bracing, or equivalent method for support of trench excavation and support of tunnel shaft excavation.


4. Access and patrol road grading and maintenance.

5. Traffic control.

6. Demolition, clearing, grubbing, and stockpiling topsoil.

7. Site utilities, including sewer, water, reclaimed irrigation water, and storm drains.

8. Earthwork, including structural excavation; pipe excavation; drilling and blasting, and rock excavation: stockpiling; backfilling, including, cement slurry fill, engineered fill, structural backfill, processing rock, and export and disposal of unsuitable material; and finish grading and restoration.

9. Tunneling, including tunnel design and submittals, portal development and shaft excavation, tunnel excavation, dewatering, muck disposal, initial support, concrete backfill, contact grouting and backfill and restoration.
10. Landscaping, revegetation, and irrigation.

11. Pipe manufacturing and installation, including delivery of pipe to the site, field welding, connection to existing pipelines, and field lining of pipe, pressure testing and disinfection.


14. Miscellaneous metals, including structural steel, grating, platforms, stairs, ladders, hatches and miscellaneous metals.

15. Roofing and roof accessories.


17. Painting and coatings, including acoustical treatments.

18. Conveyance equipment.

19. Mechanical equipment, including HVAC systems and plumbing; process piping, including fittings, couplings, supports, and small valves; pumps and motors; large diameter isolation valves, flowmeters; and control valves.

20. Air and vacuum release structures, including reinforced concrete structure and valves, piping and appurtenances.

21. Blowoff and pump well structures, including reinforced concrete structure and valves, piping and appurtenances.

22. Vent structure and overflow pipe.

23. Instrumentation and control.

24. Electrical, including raceways, conduit, conductors, grounding, boxes, and wiring devices: motors, starters, breakers and switches; transformers and bus ducts; lighting; and electric utilities, electric and telephone site work, buried conduit, and handholes.

25. Fiber optic cable system, including HDPE duct and pull box installation; cable and cable installation in duct; and system testing.

26. Cathodic protection system.

B. Meet with the Engineer and jointly review the preliminary Schedule of Values and make any adjustments in value allocations if, in the opinion of the Engineer, these are necessary to establish fair and reasonable allocation of values for the work components. The Engineer may require reallocation of major work components from items in the above listing if, in the opinion of the Engineer, such reallocation is necessary.
1.04 DETAILED SCHEDULE OF VALUES

A. Prepare and submit a detailed Schedule of Values to the Engineer based on the accepted preliminary Schedule of Values. The detailed Schedule of Values shall be used to determine monthly progress payment amounts. The Engineer shall be the sole judge of acceptable numbers, details and description of values established. If, in the opinion of the Engineer, a revision in the number of items contained in the Schedule of Values is necessary, add or delete items so identified.

B. It is anticipated that instances will occur, due to the independent but simultaneous development of the Schedule of Values and the CPM Schedule activities, where interfacing these two documents will require changes to each document. Schedule activities may need to be added to accommodate the detail of the Schedule of Values. Schedule of Value items may need to be added to accommodate the detail of the CPM Schedule activities. Where such instances arise, changes to the Schedule of Values and to the CPM Schedule activities to satisfy the CPM Schedule requirements may be proposed by the Contractor.

C. Incorporate approved Change Orders into the Schedule of Values as a single unit identified by the Change Order Number.

1.05 PAYMENT WITHHOLDINGS

A. If any submittal required by this Section is found to be incomplete or is submitted after the required submittal due date, the Water Authority may withhold payments to the Contractor in accordance with Section 10.3 of the General Conditions.

PART 2 - MATERIALS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION
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PART 1 – GENERAL

1.01 DEFINITIONS

A. Specific quality control requirements for the work are indicated throughout the Contract Documents. The term “Quality Control” includes inspection, sampling and testing, and associated requirements.

B. Registered Engineer: Wherever references are made in these Specifications to a Registered Engineer, it shall mean a Professional Engineer registered in the State of California, Department of Consumer Affairs.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. American Society for Materials


D3740 Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.

1.03 SAMPLING AND TESTING

A. Except as otherwise required, all sampling and testing shall be in accordance with the methods prescribed in the current standards of the ASTM, as applicable to the class and nature of the article or materials considered. The Engineer reserves the right to use any generally accepted system of inspection that, in the opinion of the Engineer, will ensure the Engineer that the quality of the workmanship is in full accord with the Contract Documents.

B. The Engineer reserves the right to waive tests or quality assurance measures, but waiver of any specific testing or other quality assurance measure, whether or not such waiver is accompanied by a guarantee of substantial performance as a relief from the specified testing or other quality assurance requirements as originally specified, and whether or not such guarantee is accompanied by a performance bond to assure execution of any necessary corrective or remedial work, shall not be construed as a waiver of any technical or qualitative requirements of the Contract Documents.

C. Notwithstanding the existence of such waiver, the Engineer shall reserve the right to make independent investigations and tests as specified in the following paragraph and failure of any portion of the work to meet any of the qualitative requirements of the Contract Documents, shall be reasonable cause for the Engineer to require the removal or correction and reconstruction of any such work.

D. In addition to any other inspection or quality assurance provisions that may be specified, the Engineer shall have the right to independently select, test, and analyze, at the expense of the Engineer, additional test specimens of any or all of the materials to be used. Results of such tests and analyses shall be considered along with the tests or analyses made by the Contractor to determine compliance with the applicable specifications for the materials so tested or analyzed provided that wherever any portion of the work is discovered, as a result of such independent testing or investigation by the Engineer, which fails to meet the requirements of the Contract Documents, all costs of such independent inspection and investigation and all costs of removal, correction, reconstruction, or repair of any such work shall be borne by the Contractor.
1.04 TESTING SERVICES

A. Perform all tests that require the services of a laboratory to determine compliance with the Contract Documents by an independent commercial testing firm acceptable to Engineer. The testing firm’s laboratory shall be staffed with experienced technicians, properly equipped and fully qualified to perform the tests in accordance with the specified standards.

1. The Contractor’s independent testing laboratory shall be accredited by the American Association of State Highway and Transportation Officials for the tests they will perform and as appropriate to the construction work being performed. The Contractor’s laboratory shall also be AASHTO accredited in: ASTM C1077, ASTM D3666, and ASTM D3740.

2. The Engineer shall have the right to inspect work performed by the independent testing laboratory, both at the project site and at the laboratory. This shall include inspection of the independent testing laboratory’s internal quality assurance records (quality assurance manual, equipment calibrations, proficiency sample performance, etc.).

3. Obtain the Engineer’s acceptance of the testing firm before having services performed, and pay all costs for these testing services.

4. Testing services provided by the Water Authority, if any, are for the sole benefit of the Water Authority; however, test results shall be available to the Contractor. Testing necessary to satisfy the Contractor’s internal quality control procedures shall be the sole responsibility of the Contractor.

B. Testing Services Furnished By Contractor: Perform all specified testing, unless specifically indicated otherwise. Unless otherwise specified, provide all testing services in connection with the following materials as required for the Engineer’s review:

1. Concrete materials and mix designs.

2. Masonry units and masonry grout and mortar materials and design mixtures.

3. Asphaltic concrete materials and design mixtures.

4. Embankment, fill, and backfill materials.

5. QC testing of all precast concrete.

6. Holiday testing of pipeline coatings.

7. Air testing of field-welded joints for steel pipe and fabricated specials.

8. All other tests and engineering data required for the Engineer’s review of materials and equipment proposed to be used in the work.

C. Testing Services Furnished By the Water Authority: Unless otherwise specified, the Water Authority will provide Quality Control testing services in connection with the following materials and equipment incorporated in the work:

1. Concrete strength tests.

2. Test of masonry prisms.

3. Field control test of masonry.
5. Magnetic particle or dye penetrant testing of field welds for steel pipe and fabricated specials.
6. Moisture-density and relative-density tests on embankment, fill, and backfill materials.
7. In-place field density test on embankments, fills, and backfill.
8. Other materials and equipment as specified herein.
9. Testing, including sampling, will be performed by the Engineer or the Engineer’s representative or the testing firm’s laboratory personnel, in general manner and frequency indicated in the Specifications.
10. The testing firm’s laboratory shall perform all laboratory tests within a reasonable time consistent with the specified standards and will furnish a written report of each test.
11. Furnish all sample materials and cooperate in the testing activities, including sampling. Interrupt the work when necessary to allow testing, including sampling to be performed. The Contractor shall have no claim for an increase in Contract Price or Contract Times due to such interruption. When testing activities, including sampling, are performed in the field by the testing firm’s laboratory personnel, furnish personnel and facilities to assist in the activities.

D. Transmittal of Test Reports: Written reports of tests and engineering data furnished by the Contractor for the Engineer’s review of materials and equipment proposed to be used in the work shall be submitted as specified for Shop Drawings.

1. The testing firm retained by the Contractor for material testing shall furnish five copies of written report of each test. Three copies of each test report shall be transmitted directly to the Engineer in a sealed envelope within three working days after each test is completed. The other two copies shall be transmitted to the Contractor. Consecutively number each report for each type of test.
2. The Engineer will furnish one copy of each field and laboratory QC test conducted by the Water Authority to the Contractor.

PART 2 - MATERIALS (NOT USED)

PART 3 - EXECUTION

3.01 INSTALLATION

A. Inspection: Assist the Engineer with the inspection of materials or equipment upon the arrival on the jobsite and immediately prior to installation. Remove damaged and defective items from the jobsite.

B. Measurements: Verify measurements and dimensions of the work as an integral step of starting each installation.

C. Manufacturer’s Instructions: Where installations include manufactured products, comply with manufacturer’s applicable instructions and recommendations for installation, to whatever extent these are more explicit or more stringent than applicable requirements indicated in the Contract Documents.

END OF SECTION
SECTION 01505 - MOBILIZATION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Mobilization shall include the obtaining of all permits, licenses, bonds and insurance; moving onto the site of all plant and equipment; furnishing and erecting temporary facilities, and their removal; all as required for the proper performance and completion of the work. Mobilization shall include, but not be limited to, the following principal items:

1. Moving on to the site of all Contractor's plant and equipment required for operations.
2. Installing temporary construction power, lighting and other temporary facilities.
3. Developing construction water supply.
4. Providing and maintaining a field office for the Contractor.
5. Providing and maintaining a field office for the Engineer.
6. Providing on-site sanitary facilities and potable water facilities.
7. Arranging for and erection of Contractor's work and storage yard.
8. Obtaining and maintaining all required permits, insurances and bonds.
9. Posting all OSHA required notices and establishment of safety programs.
10. Having the Contractor's superintendent at the job site full time, at all times when the construction is in progress.
11. Submitting CPM Construction Schedule.
12. Submitting Schedule of Values.
13. Maintaining the site in a clean, safe and orderly condition.
14. Demobilization and cleanup.
15. Photographic documentation of the site and access conditions prior to start of and at the completion of construction.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01370 Schedule of Values

1.03 PAYMENT FOR MOBILIZATION

A. Payment for mobilization will be based on the Contractor's lump sum breakdown submitted in accordance with Section 01370, Schedule of Values. Mobilization will be an ongoing item throughout the duration of the Contract and shall include demobilization.
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section describes the Contractor's responsibility for providing plant and equipment that is adequate for the performance of the work. Keep all plant and equipment in safe and satisfactory operating condition. Conform all work hereunder to the applicable requirements of Cal-OSHA and the OSHA Standards for Construction.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. California Code of Regulations

CFR Title 8, Subchapter 5, Electrical Safety Orders.

CFR Title 8, Subchapter 4, Construction Safety Orders, Article 36, Fire Protection and Prevention.

B. Occupational Safety and Health Administration


1.03 WATER SUPPLY

A. Provide an adequate supply of water of a quality suitable for its use, either domestic or construction. Construction water, either treated or untreated water at the Water Authority's option, will be made available by the Water Authority at no charge to the Contractor for purposes of the work if the following conditions are met:

1. Excess water must be available in the aqueduct at the point of take-off.

2. Submit a Construction Water Service Connection Plan a minimum of two weeks prior to the need for water. This plan shall indicate all piping, valves and other materials necessary to connect to Water Authority owned piping at designated blow-off, air vacuum, and air-release structures located within the project site. Do not install piping or valves until the Engineer has approved the water service plan.

3. Provide, install, and maintain piping, valves, meters, pumps or any other appurtenance necessary to connect to the Water Authority water supply. The necessary equipment shall include, as a minimum; a control valve to regulate the flow and provide isolation; a double check valve or other acceptable backflow preventer; and a meter with a recent Certification of Accuracy. Install piping such that the meter and all Contractor provided valving are located outside of the vault structure.

4. Accurately measure all water use and submit meter readings to the Water Authority when the meter is installed, at the end of each month and when the meter is removed.

5. The maximum flow rate allowed through the connection will be 1-1/2 cubic feet per second. The flow shall be controlled by the Contractor's valve which will be operated by the Contractor. Existing valves inside the Water Authority owned structure shall be operated only by Water Authority personnel.

6. Securely lock the Contractor installed valve in the closed position at the end of each workday and during all times of inactivity. Avoid wasting water and prevent unauthorized use. Do not use water from the Water Authority on any other project.

7. Coordinate all use of water, flushing of pipelines and filling of pipelines with the Engineer. All requests for use of water and for increases or decreases in quantity shall be made in writing to the Engineer two working days in advance.
B. If, at any time, these conditions are not followed, the Water Authority will immediately shut off the water supply and disconnect the Contractor's piping from the Water Authority owned facilities. The Contractor will then be responsible for securing a new source of water at no additional cost to the Water Authority.

C. Provide and operate all pumping plants, pipelines, valves, hydrants, storage tanks, and all other equipment necessary for the adequate operation of the water supply system. The Contractor shall be solely responsible for the adequate functioning of his water supply system and shall be solely liable for any claims or damages resulting from the use of same.

D. Connect the construction plant and all other parts of the work with the Contractor's water supply system to adequately protect against damage by fire. Provide hose connections and hose, water casks, chemical equipment, or other sufficient means for fighting fires, and designate, and instruct as required, responsible persons in the operation of such fire apparatus. The Contractor's fire protection program shall conform to the requirements of the California Code of Regulations, Title 8, Subchapter 4, Article 36, of Cal-OSHA; and Subpart F of the OSHA Standards for Construction.

E. Furnish all drinking water on the site during construction. Post notices conspicuously throughout the site warning the Contractor's personnel that piped water may be contaminated.

1.04 POWER AND LIGHTING

A. Provide all power required for construction operations, and provide and maintain all temporary power lines required to perform the work in a safe and satisfactory manner.

B. Provide suitable light for work conducted at night or under conditions of deficient daylight to insure proper work and to afford adequate facilities for inspection and safe working conditions.

C. Temporary connections for electricity shall be subject to approval of the Engineer and the power company representative. Remove temporary electrical connections in like manner prior to final acceptance of the work.

D. Securely fasten in place and maintain all wiring for temporary electric light and power. All electrical facilities shall conform to the requirements of Title 8, Industrial Relations, Subchapter 5, Electrical Safety Orders, of the California Code of Regulations; and Subpart K of the OSHA Safety and Health Standards for Construction.

1.05 COMMUNICATIONS

A. Provide and maintain at all times at the project site during the progress of the work not less than one telephone in good working order.

B. Permit the Engineer and the Water Authority free and unlimited use of the Contractor's telephone facilities for all calls that do not involve toll charges. Calls originated by the Engineer or the Water Authority, which involve toll charges, shall be billed to the Water Authority by the Contractor at the rates charged by the Telephone Company.

1.06 REMOVAL OF TEMPORARY UTILITIES

A. Before final acceptance of the work, remove all temporary connections and piping installed by the Contractor, and all affected improvements to their original condition, or better, to the satisfaction of the Engineer and to the agency owning the affected utility.

PART 2 - MATERIALS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section describes the procedures for locating, protecting, and relocating existing underground utilities and surface improvements.

B. Do not perform work that would affect any oil, gas, sewer, or water pipeline; any telephone, telegraph, or electric transmission line; any fence; or any other structure, until authorization has been obtained from the owner of the improvement. Provide the owner of the improvement due notice of the beginning of work, and remove, shore, support, or otherwise protect such pipeline, transmission line, ditch, fence, or structure, or replace same.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02653 Steel Pipe

1.03 UNDERGROUND SERVICE ALERT

A. Except in an emergency, contact Underground Service Alert at least two working days, but not more than 14 calendar days, prior to commencing any excavation and obtain an inquiry identification number from that notification center. Do not commence excavation without a current inquiry identification number assigned to the Contractor or any subcontractor of the Contractor and until the Engineer has been given the number by the Contractor. Comply with all applicable laws and regulations in locating subsurface installations and in excavating.

1. An emergency is defined as a sudden, unexpected occurrence, involving a clear and imminent danger, demanding immediate action to prevent or mitigate loss of, or damage to, life, health, property, or essential public services. An emergency includes such occurrences as fire, flood, earthquake, or other soil or geologic movements, as well as such occurrences as riot, accident, or sabotage.

2. Subsurface installations means any underground pipeline, conduit, duct, wire, or other structure.

1.04 EXISTING UTILITIES AND IMPROVEMENTS

A. Prior to submittal of Shop Drawings, and prior to commencing any excavations for new pipelines or structures, conduct investigations, including exploratory excavations and borings, to determine the location and type of underground utilities and services connections that could result in damage to such utilities. The positions of these utilities as derived from such records are shown in the Contract Documents.

B. No excavations were made to verify the locations shown for underground utilities, unless specifically stated in the Contract Documents. The service connections to these utilities are not shown on the Plans, and the locating of such service connections is the responsibility of the Contractor.

C. Prior to submittal of Shop Drawings, or to the commencing of any excavations for new pipelines or structures, conduct investigations, including exploratory excavations and borings, to determine the locations and type of underground utilities and service connections which could result in damage to such utilities. Prepare a report (i.e., Potholing Report) identifying each utility by its size, elevation, station and material of construction. Immediately notify the Engineer and the utility in writing as to any utility discovered in a different position than as marked in the field or shown in the Contract Documents, or any utility which is not marked in the field or shown in the Contract Documents.

D. Prepare a support plan for each utility crossing detailing the intended support method. Obtain approval from the owner of the utility prior to excavation of the utility.
E. The number of exploratory excavations required shall be that number which is sufficient to determine the alignment and grade of the utility. Conform to local agency requirements for backfill and pavement repair subsequent to performing exploratory excavations.

F. Protect all underground utilities and other improvements which may be impaired during construction operations. Take all possible precautions for the protection of unforeseen utility lines to provide for uninterrupted service and to provide such special protection as may be necessary.

G. Where the proper completion of the work requires the temporary or permanent removal and/or relocation of an existing utility or other improvement which is at the location shown on the Plans, remove and temporarily replace or relocate such utility or improvement in a manner satisfactory to the Engineer and the owner of the facility. Restore or replace the utility or improvement as nearly as possible to its former locations and to as good or better condition than found prior to removal.

H. Where the proper completion of the work requires the temporary or permanent removal and/or relocation of an existing utility which is not shown on the Plans, or which is not shown in the location indicated on the Plans, work on the utility and payment for such work will be as described below. Submit a method for correcting such utility interferences.

1. Main or Trunkline Facilities
   a. Compensation will be provided by the Water Authority (pursuant to § 4215 of the Government Code) for the costs of locating, repairing damage not due to the failure of the Contractor to exercise reasonable care, and removing, relocating, protecting or temporarily maintaining main or trunkline utility facilities not indicated with reasonable accuracy in the Contract Documents, and for equipment in the project necessarily idled during such work. Compensation will be provided in accordance with Section 3.3 of the General Conditions.
   b. Alternatively, the Engineer may make changes in the alignment and grade of the work in accordance with Section 3.3 of the General Conditions, to eliminate the necessity to remove, relocate, or temporarily maintain the utility, or the Engineer may make arrangements with the owner of the utility for such work to be done at no cost to the Contractor.
   c. The Contractor shall not be assessed a forfeiture for delay in completion of the work when such delay is caused by the failure of the Engineer or the owner of the utility to provide for the removal, relocation, protection, or temporary maintenance of all such main or trunkline facilities not indicated with reasonable accuracy.
   d. The owner of the utility shall have the sole discretion to perform repairs or relocation work or to permit the Contractor to do such repairs or relocation work at a mutually agreed upon price.

2. Other Utilities
   a. When it is necessary to remove, relocate, or temporarily maintain a service connection, the cost of which is not required to be borne by the owner thereof, the Contractor shall bear all expenses incidental to the work on the service connection. The work on the service connection shall be done in a manner satisfactory to the owner thereof; it being understood that the owner of the service connection has the option of doing such work with his own forces or permitting the work to be done by the Contractor.
   b. When it is necessary to remove, relocate, or temporarily maintain a utility which is not shown on the Plans or is in a position different from that shown on the Plans and were it in the position shown on the Plans would not need to be removed, relocated, or temporarily maintained, and the cost of which is not required to be borne by the owner thereof, the Engineer will make arrangements with the owner of the utility for such work to be done at no cost to the Contractor, or will require the Contractor to do such work in accordance with Section 3.3 of the General Conditions or will make changes in the alignment and grade of the work to eliminate the necessity.
to remove, relocate, or temporarily maintain the utility. Changes in alignment and grade will be ordered in accordance with the Section 3.3 of the General Conditions.

I. No representations are made that the obligations to move or temporarily maintain the utility and to pay the cost thereof is or is not required to be borne by the owner of such utility, and it shall be the responsibility of the Contractor to investigate to find out whether or not said cost is required to be borne by the owner of the utility.

J. The right is reserved to governmental agencies and to owners of utilities to enter at any time upon any street, alley, right-of-way, or easement for the purpose of making changes in their property made necessary by the work and for the purpose of maintaining and making repairs to their property.

K. The Contractor shall take precautions to prevent damage to all pavement and other surfaces outside the limits of necessary excavation, whether on public streets, Water Authority rights-of-way, or private property and roads. All damaged pavement or surfaces on public streets, Water Authority rights-of-way, or private property shall be replaced in accordance with accepted standards of the jurisdictional agency or standards of the County of San Diego. Where the foregoing standards are silent, replace pavement to the existing thickness plus one inch. For the purposes of this section, the terms “pavement” and “surfaces” shall be deemed to include base materials.

L. The Contractor is to maintain reasonable access from public and private streets to all adjacent properties at all times during construction. Prior to restricting normal access from public or private streets to adjacent properties, the Contractor shall notify each property owner or responsible person, informing him of the nature of the access restriction, the approximate duration of the restriction, and the alternate access available for that particular property.

M. To minimize access restrictions to driveways, either backfill, compact and provide temporary pavement or provide steel plates or bridging sufficient to support vehicular traffic across the trench in front of the driveway during nonworking hours. Single access driveways may be closed only during construction activity within the driveway area.

1.05 WORK OVER WATER AUTHORITY-OWNED PIPELINES

A. Do not operate vehicles or equipment and do not place, push, store or stockpile vehicles, equipment, supplies, tools, fabricated or manufactured articles, fuel supplies, field office facilities, excavated or imported materials of any kind, and do not perform any work within 15 feet of the centerline of existing Water Authority-owned pipelines, except where specified or shown on the Plans, or where permission is granted in writing by the Engineer.

B. At designated crossing locations of existing Water Authority-owned pipelines, limit equipment loads to the live load limits shown or specified. At these locations, if the Contractor elects to cross existing Water Authority-owned pipelines with equipment loads in excess of the live load limits shown or specified, erect temporary bridges for use by equipment that exceeds the specified live load limits. Design the temporary bridges and bridge supports to transfer no more than the specified live load limit to the existing ground surface within 15 feet of the centerline of existing Water Authority-owned pipelines. Submit structural calculations of each temporary bridge and bridge support and detailed fabrication and installation drawings to the Engineer for acceptance. Post at each bridge crossing the maximum allowable load for that bridge and include a listing of equipment used on the job that can use the bridge to cross existing Water Authority-owned pipelines.

C. Obtain written permission from the Engineer for crossing existing Water Authority-owned pipelines where crossing locations are not designated or specified, or where the Contractor elects to cross existing Water Authority-owned pipelines at locations other than those designated on the Plans or specifications. At these locations, erect temporary bridges for use by all equipment crossing existing Water Authority-owned pipelines. Design the temporary bridges and bridge supports to transfer no load to the existing ground surface within 15 feet of the centerline of existing Water Authority-owned pipelines. Submit structural calculations of each temporary bridge and bridge support and detailed fabrication and installation drawings to the Engineer for acceptance. Post at each bridge crossing the maximum allowable load for that bridge.
and include a listing of equipment used on the job that can use the bridge to cross existing Water Authority-owned pipelines.

D. Install temporary fencing to delineate the entire length and width of all designated and Contractor elected material storage and crossing locations over existing Water Authority-owned pipelines.

1.06 STREET OR ROADWAY MARKERS

A. Do not destroy, remove, or otherwise disturb any existing survey markers or other existing street or roadway markers without proper authorization. Do not perform any pavement breaking or excavation until all survey or other permanent marker points that will be disturbed by the construction operations have been properly referenced for restoration. Accurately restore all survey bench marks, markers or points disturbed by the Contractor activities after all surface restoration has been completed.

1.07 APPROVAL OF REPAIRS

A. All repairs to a damaged improvement are subject to inspection and written approval by an Authorized Representative of the improvement owner before being concealed by backfill or other work.

1.08 MAINTAINING IN SERVICE

A. All utilities including oil and gasoline pipelines, power, and telephone or communication cable ducts, gas and water mains, irrigation lines, sewer lines, storm drain lines, poles, and overhead power and communication wires and cables encountered along the line of the work shall remain continuously in service during all the operations under the Contract, unless other arrangements satisfactory to the Engineer are made with the owner of said utility. The Contractor shall be responsible for and shall repair all damage due to its operations, and the provisions of this Section shall not be abated even in the event such damage occurs after backfilling or is not discovered until after completion of the backfilling.

1.09 NOTIFICATION BY THE CONTRACTOR

A. Prior to commencing any excavation in the vicinity of any existing underground facilities, notify the respective authorities representing the owners or agencies responsible for such facilities not less than two days nor more than 14 days prior to excavation so that a representative of said owners or agencies can be present during such work if they so desire.

1.10 PRECONSTRUCTION VIDEO

A. Prior to commencing any work, a pre-construction video in DVD format shall be made to illustrate all areas that may be disrupted by the work. Include on the video Water Authority access patrol roads and rights-of-way, construction access roads, all public and private streets used for access to and from the work site, environmentally sensitive areas, the inside condition of all sanitary and storm sewer pipelines and laterals that are located within the construction zone and other such areas as directed by the Engineer that may be disturbed or which are to be protected from the Contractor’s operations. Notify the Engineer so that the Engineer may accompany the Contractor during the videotaping. Deliver one copy of the video to the Water Authority at the pre-construction conference.

B. The Engineer will review the video for content, coverage and quality prior to the beginning of construction. Retake any portion of the video not of clear focus, color or adequate coverage, as determined by the Engineer, with video camera. Deliver one copy of the final video to the Engineer prior to the commencement of work.

PART 2 - MATERIALS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section describes the Contractor’s responsibility to implement and maintain temporary controls. The Contractor shall provide the necessary temporary controls required for the performance of the work.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Occupational Safety and Health Administration

OSHA Standards-29 CFR, Subpart D, Section 1926.51, Sanitation.

1.03 DUST CONTROL

A. Perform continuous dust abatement measures in accordance with the San Diego Air Pollution Control District's regulations to prevent construction from producing dust in amounts harmful to persons or animals or causing a nuisance to persons or animals living nearby or occupying buildings in the vicinity of the work. Use water or dust prevention to control dust.

1.04 ACCESS ROADS AND PARKING AREAS

A. The Contractor and his employees will be permitted to park their vehicles within the areas disturbed by construction activities that are also located within the limits of Water Authority-owned rights-of-way and easements. Provide facilities offshore or on public streets on which parking is permitted by local and state codes and ordinances.

1.05 STREET SWEEPING

A. Keep all public and private roads used for ingress and egress in a clean and neat condition. Take measures, as necessary, to prevent the tracking or accumulation of materials on roads. Sweep or wash all loose materials and mud from equipment before entering the road. Provide street sweeping services when requested by the Engineer.

1.06 DEBRIS CONTROL

A. Keep the job site neat and orderly at all times. Remove and properly dispose of construction debris on a regular basis. Remove debris as work is completed.

1.07 FIRE DANGER

A. Minimize fire danger in the vicinity of and adjacent to the construction site. Provide labor and equipment to protect the surrounding private property from fire damage resulting from construction operations.

1.08 PUBLIC SAFETY

A. Provide temporary fencing of all open or partially open trenches and excavations, all open or partially completed structures, and all work and storage areas at all times while unattended by workmen. Temporary fencing shall be a minimum six feet high chain link with posts spaced no more than eight feet apart. Temporary fencing materials need not be new, but shall be in good condition. Gates shall be framed chain link with chains and padlocks. Provide the Engineer a minimum of two keys for each padlock. Erect temporary fencing immediately after starting an excavation and promptly remove the temporary fencing when the excavation has been backfilled or the structure secured.
1.09 SANITATION

A. Provide fixed or portable chemical toilets wherever needed for the use of employees. Toilets at construction job sites shall conform to the requirements of Subpart D, Section 1926.51 of the OSHA Standards for Construction.

B. Establish a regular daily collection of all sanitary and organic wastes. Dispose of away from the site all wastes and refuse from sanitary facilities provided by the Contractor or organic material wastes from any other source related to the Contractor's operations in accordance with all laws and regulations pertaining thereto.

1.10 ABATEMENT OF AIR POLLUTION

A. Comply with all applicable federal, state, county, and city laws and regulations concerning the prevention and control of air pollution.

B. Perform construction activities and operate equipment in a manner which will minimize atmospheric emissions or discharges of air contaminants. Do not operate equipment or vehicles that show excessive emissions of exhaust gases on the site.

1.11 NOISE CONTROL

A. Comply with all local sound control and noise level rules, regulations, and ordinances which apply to any work performed pursuant to the Contract.

B. Equip each internal combustion engine used for any purpose on the job or related to the job with a muffler of a type recommended by the manufacturer. Do not operate internal combustion engines on the project without said muffler.

C. Noise level requirements shall apply to all equipment on the job or related to the job, including but not limited to trucks and transient equipment that may or may not be owned by the Contractor. Avoid the use of loud sound signals in favor of light warnings except where required by safety laws for the protection of personnel.

1.12 CHEMICALS

A. All chemicals used during project construction or furnished for project operation, whether defoliant, soil sterilant, herbicide, pesticide, disinfectant, polymer, reactant or of other classifications, shall show approval of either the U.S. Environmental Protection Agency or the U.S. Department of Agriculture. Use of all such chemicals and disposal of residues shall be in strict accordance with the printed instructions of the manufacturer.
SECTION 01630 - PRODUCT SUBSTITUTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section describes the procedural requirements for requests for material and equipment substitutions.

1.02 SUBSTITUTION

A. The Contract, if awarded, will be on the basis of materials and equipment described in the Contract Documents without the consideration of possible substitute or "or equal" items. Whenever it is indicated in the Contract Documents that a substitute or "or equal" item of material or equipment may be furnished or used by the Contractor if acceptable to the Engineer, application for such acceptance will not be considered by the Engineer until after the execution of the Contract.

B. The use of approved substitutes or "or equals" shall in no way relieve the Contractor from compliance with the Contract Documents. The Contractor shall bear all extra cost resulting from providing or using approved substitutes.

C. The listing of any manufacturer or supplier in the Contract Documents does not, and is not intended to, grant any right, title, or interest in the Contract for the benefit of the named manufacturer or supplier.

D. Where a material or equipment item is specified by two or more manufacturer or supplier names, the Contractor may provide either one of the materials or equipment so specified, providing that all requirements of the Contract Documents are met. Only one brand, kind, or make of material or equipment shall be used or installed throughout the work, notwithstanding that material or equipment from two or more manufacturers may be specified for the same purpose.

E. For convenience in designation in the specifications, equipment, or materials to be incorporated on the work may be designated under a trade name or the name of a manufacturer and his catalog information. The use of alternative equipment or material which is of equal quality and of the required characteristics for the purpose intended will be permitted, subject to the following:

1. The burden of proof as to the comparative quality and suitability of alternative equipment or materials shall be upon the Contractor and he shall furnish, at his own expense, seven copies of complete description, information, and performance data, showing the equality of the materials or equipment offered to those specified, and such other necessary or related information as may be required by the Engineer. Where appropriate, at Contractor's expense, independent testing or evaluation at qualified test facilities, including destructive testing, may be required as a condition of acceptance.

2. The Engineer will be the sole judge as to the comparative quality and suitability of the alternative equipment or materials, and his decision shall be final.

F. The Contractor's application of the substitution request shall contain the following statements and/or information which shall be considered by the Engineer in evaluating the proposed substitution:

1. The evaluation and acceptance of the proposed substitute will not prejudice the Contractor's achievement of substantial completion on time.

2. Whether or not acceptance of the substitute for use in the work will require a change in any of the Contract Documents to adopt the design to the proposed substitute.

3. All variations of the proposed substitute from that specified will be identified.

4. Available maintenance, repair, and replacement service will be indicated.
5. Itemized estimate of all costs that will result directly or indirectly from acceptance of such substitute, including cost of redesign and claims of other Contractors affected by the resulting change.

G. The Water Authority may require the Contractor to furnish a special performance guarantee or other surety with respect to any substitute.

H. The Contractor shall have 90 days after the date of receipt of the Notice to Proceed for submission of any and all “or equal” items. Upon receipt, by the Water Authority, of a complete “or equal” package, as determined by the Engineer, the Water Authority shall have 45 days to approve or reject the product substitution.

I. If substitute materials or equipment are installed without the Engineer’s approval, remove the unauthorized materials and equipment and replace with items required by the Contract Documents at no additional cost to the Water Authority.

PART 2 - MATERIALS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION
SECTION 01700 - CONTRACT CLOSEOUT

PART 1 - GENERAL

1.01 FINAL CLEANUP
   A. Promptly remove from the vicinity of the completed work, all rubbish, unused materials, concrete forms, construction equipment, and temporary structures and facilities used during construction. Final acceptance of the work by the Water Authority will be withheld until the Contractor has satisfactorily complied with the foregoing requirements for final cleanup of the project site, including all temporary construction areas.

1.02 CLOSEOUT TIMETABLE
   A. Establish dates for equipment testing, pressure testing and disinfection, fiber optic cable system testing, cathodic protection system measurements, and other required tests. Establish such dates not less than one week in advance to allow the Engineer sufficient time to schedule attendance at such activities.
   B. Notify the Engineer when in the Contractor's judgment, the work is considered ready for its intended use. Provide a list of all work items that remain to be completed. The Engineer shall make an inspection of the work to determine the status of completion. Acceptance of the work shall be in accordance with Section 7.9 of the General Conditions.

1.03 FINAL SUBMITTALS
   A. Prior to requesting final payment, obtain and submit the following items to the Engineer:
      1. Written guarantees, where required.
      2. Operating manuals and instructions.
      3. Maintenance stock items; spare parts; special tools.
      4. Completed Record Drawings.
      5. Certificates of inspection and written acceptance by permittee, local governing agencies having jurisdiction, and property owners.
      6. Written Releases of Liens and claims from all parties who are entitled to liens and claims against the subject project, pursuant to the provisions of law.
      7. A certificate stating that all Contractor generated hazardous waste has been removed from the site.

1.04 MAINTENANCE AND GUARANTEE
   A. Comply with the maintenance and guarantee requirements contained in the General Conditions.
   B. Replacement of earth fill or backfill, where it has settled below the required finish elevations, shall be considered as a part of such required repair work, and any repair or resurfacing constructed by the Contractor which becomes necessary by reason of such settlement shall likewise be considered as a part of such required repair work unless the Contractor shall have obtained a statement in writing from the affected private owner or public agency releasing the Water Authority from further responsibility in connection with such repair or resurfacing.
   C. Make all repairs and replacements promptly upon receipt of written order from the Water Authority. If the Contractor fails to make such repairs or replacements promptly, the Water Authority reserves the right to do the work and the Contractor and his surety shall be liable to the Water Authority for the cost thereof.
D. Any latent defects which may appear to existing utilities during the warranty period resulting from settlement of backfill, pipe leakage or other causes resulting from the construction shall be promptly repaired by the Contractor upon notice by the Water Authority.

PART 2 - MATERIALS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. Submit for review and comment by the Engineer six copies of an Operations and Maintenance Manual containing all manufacturers’ operation, maintenance, and other data pertinent to equipment supplied for the project. Upon receipt of the Engineer’s written acceptance of the Operations and Maintenance Manual, submit two printed copies of the accepted manual and one electronic version of all printed documents in portable document format (pdf) on CD or DVD disc. The requirements of this section are in addition to the individual operation and maintenance manuals submitted with each final shop drawing submittal.

1.02 OPERATION AND MAINTENANCE DATA

A. The Operation and Maintenance Manual shall include, but not be limited to, the following items:

1. List of equipment furnished for project with name, mailing address, email address, and telephone number of vendor; and name, mailing address, email address, and telephone number of nearest service center.

2. List of serial numbers of equipment furnished.

3. Equipment data sheets.

4. Installation instructions.

5. Startup and operation instructions.


7. Manufacturers’ parts lists, including list of fuses, lamps, seals, and other expendable equipment and devices. Specify size, type, and ordering description. List name, mailing address, email address, and telephone number of parts vendor.

8. Troubleshooting guide that indicates common problems or malfunctions, and steps necessary to identify and correct the problem.

9. Certifications, when applicable.

10. Testing documents, when applicable.


12. Copy of final shop drawings.

PART 2 - MATERIALS - NOT USED
PART 3 - EXECUTION

3.01 PREPARE MANUALS

A. Compile and organize the manufacturers’ operation, maintenance materials, and other data pertinent to equipment supplied for the project into three-ring binders. The Operations and Maintenance manual shall have a cover sheet, spine label, table of contents listing each piece of equipment contained in the manual, and section tabs labeled with the name of the equipment, e.g. 6-inch Butterfly Valves. When the data exceeds the size of binder, label each binder as a volume, e.g. Volume I, Mechanical, Volume II, Electrical.

B. Title the first section of the manual “Equipment List” and include the following:

1. List of equipment furnished for project with name, mailing address, email address, and telephone number of vendor, and name, mailing address, email address, and telephone number of nearest service center.

2. List of serial numbers of equipment furnished.

3. List of order numbers of equipment furnished.

C. Organize the Operations and Maintenance data in the order shown under paragraph 1.02A. Provide section tabs for each data item.

D. Blank equipment data sheet and sample data sheets are included in this section.

END OF SECTION
<table>
<thead>
<tr>
<th>Preventive Maintenance Program</th>
<th>Equipment Record Number</th>
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<tbody>
<tr>
<td><strong>EQUIPMENT DESCRIPTION</strong></td>
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<td>Mfr.:</td>
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<td>Vendor Rep:</td>
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<tr>
<td>Phone:</td>
<td>Phase:</td>
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<tr>
<td>Maintenance Work to be Done</td>
<td>Frequency*</td>
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**OPERATING REQUIREMENTS AND REFERENCE**

*D - daily, W - weekly, B - biweekly, M - monthly, Q - quarterly, S - semiannually, A – annually*
### Preventive Maintenance Program

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<td>W/Space Heater</td>
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<td>Newport Beach, CA 92663</td>
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<td>Phone: 714/752-0505</td>
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<td>Frequency*</td>
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<td>1. Operate all valves and</td>
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<td>2. Check packing.</td>
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<td>3. Checking pumping unit</td>
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<td>debris.</td>
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### OPERATING REQUIREMENTS AND REFERENCE

For manufacturer’s instructions regarding installation, operation, maintenance, and trouble shooting of this equipment, see Volume ________, Section ________.

*D - daily, W - weekly, B - biweekly, M - monthly, Q - quarterly, S - semiannually, A - annually*
## SAMPLE

Preventive Maintenance and Operating Requirement Sheets

<table>
<thead>
<tr>
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<tr>
<td>Vendor Address:</td>
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<tr>
<td>Vendor Rep:</td>
<td>Voltage:</td>
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<tr>
<td>Phone:</td>
<td>Phase:</td>
</tr>
<tr>
<td></td>
<td>rpm:</td>
</tr>
</tbody>
</table>

**Maintenance Work to be Done** | **Frequency***
---|---
4. Lubricate bearing frame and motor bearings (consult manufacturer's instructions for type of grease or oil.) | Q
5. Disassemble and change or repair the following a) impeller, b) shaft sleeve, d) rotary seals, and e) sleeve bearings. | A

---

*D - daily, W - weekly, B - biweekly, M - monthly, Q - quarterly, S - semiannually, A - annually
SECTION 02110 - CLEARING AND GRUBBING

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section describes the work included in clearing, grubbing, stripping, and mulching to prepare the project site for construction operations, and to salvage topsoil and vegetative material for later revegetation of cleared areas.

B. Perform mulching of vegetative material, stripping of topsoil and salvaging of such within all construction disturbed areas to the limits designated on the Plans and as specified herein. Comply with prohibitions, if any, on the removal of vegetation in accordance with regulatory permit conditions. Comply with seasonal restrictions as indicated on such permits, or as specified herein.

C. The removal and storage of topsoil and existing vegetation is included in the work of this section. Topsoil replacement is included in Section 02200, Earthwork.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02200 Earthwork

B. Section 02270 Temporary Erosion Control

C. Section 02510 Access Roads

D. Section 02830 Fencing

E. Section 02940 Revegetation

1.03 SUBMITTALS

A. Storm Water Pollution Prevention Plan in accordance with the National Pollution Discharge Elimination System General Permit for Storm Water Discharges Associated with Construction Activities prior to commencing clearing and grubbing operations. The erosion and sedimentation control measures included in the SWPPP shall be in accordance with Section 02270, Temporary Erosion Control.

B. Copies of required permits for off-site disposal of cleared material not specified for reuse.

C. List of equipment to be used for clearing, grubbing, stripping and mulching.

1.04 DEFINITIONS

A. Topsoil is defined as the top layer of pre-construction ground surfaces and earthen material, excluding vegetation. Salvage material shall include topsoil and mulched native vegetation.

PART 2 - MATERIALS

2.01 TREE WOUND PAINT

A. Tree wound paint shall be bituminous based of standard manufacture for treating tree cuts and wounds.

2.02 PROTECTIVE FENCING AND ENVIRONMENTAL FLAGGING

A. Protective fencing shall be four foot tall lightweight polypropylene, orange color barrier safety fencing.
B. Environmental flagging shall be single strand fluorescent red or orange color, 3-mil thick, 1-3/16 inch wide vinyl tape.

C. Support posts for protective fencing and environmental flagging shall be four foot tall above grade, placed at maximum spacing of ten feet on center.

PART 3 - EXECUTION

3.01 CLEARING AND GRUBBING LIMITS

A. Clear and grub only the areas to be disturbed by excavations, embankments, structures, slabs and roadways. Do not clear and grub topsoil stockpile areas.

B. Existing trees, shrubbery and other vegetation may not be shown on the Plans. Inspect the site prior to beginning of clearing and grubbing operations to document the nature, location, size and extent of vegetation, structures, fencing, pavement, poles, posts, rock outcroppings and other items within the designated area to be cleared, grubbed, stripped, mulched or preserved, as specified herein. Prior to the start of grading, verify with the Engineer the areas where topsoil is to be salvaged and the locations where topsoil will be stockpiled.

3.02 PROTECTION

A. Protect and preserve in place all trees, plants, lawns, structures, and other improvements that are specifically designated on the Plans to be preserved, or are not required to be removed for the performance of the work.

B. Conduct clearing and grubbing operations in a manner that will preserve and protect vegetation beyond the limits of clearing and grubbing. No filling, excavating, trenching or stockpiling of materials shall be permitted within the drip line of the protected vegetation. The drip line is defined as a circle drawn by extending a line vertically to the ground from the outermost branches of the vegetation. To prevent soil compaction within the drip line area, no equipment will be permitted within this area.

C. When protected trees are close together, restrict entry to area within drip line by fencing. In areas where no fence is erected, protect tree trunks two inches or greater in diameter, by encircling the trunk entirely with boards held securely by 12-gauge wire and staples. This protection shall extend from ground level to a height of six feet. Cut and remove tree branches only where such cutting is necessary to effect construction operation. Remove branches other than those required to effect the work to provide a balanced appearance of any tree. Treat scars resulting from the removal of branches with tree wound paint. Replace trees in kind which die as a result of construction work.

D. Prior to the start of clearing and grubbing, schedule and attend a site observation visit with the Engineer to verify existing conditions and the location of environmentally sensitive areas. Erect protective fencing or environmental flagging around environmentally sensitive areas and along the rights-of-way as shown on the Plans and as directed by the Engineer during the site observation visit. Maintain fencing and flagging in good condition for the duration of the work.

3.03 CLEARING

A. Remove trees, stumps, shrubs, brush, limbs and other vegetative growth from areas where topsoil salvaging is not required. Remove evidence of their presence from the surface including sticks and branches greater than one inch in diameter or thickness.

B. Remove all fencing that interferes with construction of new facilities. Where shown on the Plans, salvage fencing materials for later reconstruction or construct new fencing in accordance with Section 02830, Fencing.
3.04 MULCHING OF NATIVE VEGETATION

A. In areas where topsoil salvaging is required, mulch or crush the existing native vegetation into the topsoil prior to salvaging. Native vegetation shall include grasses, brush, and woody materials. Remove rocks, stumps and branches larger than 12 inches and dispose offsite.

B. Mulch vegetative material to a size no larger than six inches long by one inch wide by any mechanical means available. Incorporate and store mulched native vegetation with salvaged topsoil.

3.05 TOPSOIL STRIPPING AND SALVAGING

A. Strip topsoil to a depth of six inches in all disturbed areas, unless otherwise shown or specified. Where the in situ topsoil depth exceeds six inches, and upon written approval of the Engineer, the Contractor may remove suitable topsoil to a depth as directed by the Engineer to meet topsoil replacement requirements described in Section 02200, Earthwork. Do not contaminate topsoil with other excavated materials.

B. Stockpile topsoil within the limit of construction, separate from other excavated materials and pile free of undesirable materials. Place topsoil in elongated piles, or "windrows," no greater than six feet in height. Windrows shall run parallel to the easement edge from which the topsoil was removed, or at offsite locations approved by the Engineer. Keep separate stockpiles of the topsoil and native vegetation that is salvaged from distinct vegetative types.

C. Provide the Engineer with an estimate of the quantity of salvaged topsoil at each stockpile location. Mark stockpiled topsoil with signs noting the location where the topsoil was removed, and the type of vegetation that was mulched.

D. Prior to stockpiling topsoil, spread clean rice straw or crushed native vegetation on the ground surface to delineate between the in-situ and salvaged topsoil.

E. Do not allow weed growth on salvaged topsoil stockpiles. Control weeds in accordance with Section 02940, Revegetation. Do not apply pre-emergent herbicides on topsoil stockpiles. Remove and dispose offsite any weed growth before weeds produce mature seed heads.

F. If erosion occurs to stockpiled topsoil, or as requested by the Engineer to control erosion, hydroseed without seed in the stockpile areas in accordance with Section 02940, Revegetation.

G. Protect topsoil stockpiles from intrusion by erecting and maintaining protective fencing around stockpiles.

H. If the Contractor fails to perform topsoil salvaging, or if the quantity of topsoil salvaged does not equal the quantity of topsoil available for salvaging due to improper removal, storage or maintenance of stockpiles, import additional topsoil in quantities sufficient to meet the topsoil replacement requirements described in Section 02200, Earthwork. Imported topsoil shall be of natural, friable material possessing the characteristics of representative in situ materials.

3.06 GRUBBING

A. Remove wood or root matter below the ground surface remaining after clearing and stripping, including stumps, trunks, roots or root systems greater than one inch in diameter or thickness to a depth of 12 inches below the ground surface.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes materials, installation, maintenance, operation, and removal of temporary dewatering systems for the control and disposal of surface and ground waters.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02200 Earthwork
B. Section 02270 Temporary Erosion Control
C. Section 02310 Tunneling
D. Section 02315 Portal Area Development
E. Section 02655 Installation of Pipe

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. California Regional Water Quality Control Board General Waste Discharge Requirements for Groundwater Remediation and Dewatering Waste Discharges, Order Numbers 95-25 and 96-41. Copies of the Waste Discharge Requirements may be obtained from the Water Authority.

1.04 JOB CONDITIONS

A. Methods of dewatering may include sump pumping, single or multiple stage well point systems, eductor and ejector type systems, deep wells, and combinations thereof.

B. Locate dewatering facilities where they shall not interfere with utilities and construction work to be performed by others.

C. Modify dewatering procedures which cause, or threaten to cause, damage to new or existing facilities, so as to prevent further damage. Install settlement gauges, as necessary, to monitor settlement of critical structures or facilities adjacent to areas of dewatering. Control the rate of dewatering to avoid all objectionable settlement and subsidence.

D. Comply with Regional Water Quality Control Board Waste Discharge requirements under Orders 96-41 and 95-25. Obtain authorization, as required, prior to discharge of groundwater, and comply with the sampling, testing, monitoring, and reporting requirements specified therein.

1.05 SUBMITTALS

A. Shop Drawings which, at a minimum, indicate the proposed type of dewatering system; the arrangement, location, and depths of systems components; a complete description of equipment and instrumentation to be used, with installation, operation and maintenance procedures; and the methods of disposal of pumped water.

B. Well installation or destruction permits.
PART 2 - MATERIALS

2.01 MATERIALS AND EQUIPMENT

A. Furnish and maintain all materials, tools, equipment, facilities, and services as required for providing the necessary dewatering work and facilities.

B. Provide piezometers for monitoring groundwater levels and other instruments and measuring devices as required.

PART 3 - EXECUTION

3.01 DEWATERING

A. Perform dewatering in accordance with approved Shop Drawings. Keep the Engineer advised of any changes made to accommodate field conditions and, on completion of the dewatering system installation, revise and resubmit Shop Drawings as necessary to indicate the installed configuration.

B. Organize dewatering operations to lower the groundwater level in excavations as required for prosecution of the work, and to provide a stable, dry subgrade for the prosecution of construction operations.

C. Maintain water level at lower elevations, so that no danger to structures can occur because of buildup of excessive hydrostatic pressure, and provide for maintaining the water level a minimum of two feet below the subgrade, unless otherwise permitted by the Engineer.

D. Maintain groundwater level a minimum of five feet below the prevailing level of backfill being placed.

E. Dispose of water in such a manner as to cause no injury or nuisance to public or private property, or be a menace to the public health. Dispose of the water in accordance with applicable regulatory agency requirements. Do not drain trench water through the pipeline under construction.

F. The dewatering operation will be continuous, so that the excavated areas shall be kept free from water during construction, while concrete is setting and achieves full strength, and until backfill has been placed to a sufficient height to anchor the work against possible flotation.

G. Prevent disposal of sediments from the soils to adjacent lands or waterways by employing necessary methods, including settling basins. Locate settling basins away from watercourses to prevent silt-bearing water from reaching the watercourse during flow regime.

H. Where excavations may obstruct the natural flow of a watercourse, implement measures to control and dispose of the surface water that will not adversely affect water quality or beneficial uses of the watercourse. Divert watercourse flows around excavation areas by constructing barriers, temporary culverts, new channels or other appropriate means.

I. Do not allow water containing mud, silt or other pollutants from aggregate washing or other construction activities to enter a watercourse or be placed in locations that may be subjected to high storm flows.

3.02 RECORDS

A. Provide a daily record of the average flow rate. Provide water quality testing as required by the Regional Water Quality Control Board.

B. Observe and record the elevation of the groundwater during the period that the dewatering system is in operation.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes materials, testing and other requirements of earthwork for excavation, trenching, shoring, backfilling, compaction and grading necessary for the construction of the work. The excavation shall include the removal and disposal of materials of whatever nature encountered, including water that would interfere with the proper construction and completion of the work.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01530 Protection of Existing Facilities
B. Section 02110 Clearing and Grubbing
C. Section 02140 Dewatering
D. Section 02270 Temporary Erosion Control
E. Section 02315 Portal Area Development
F. Section 02510 Access Roads
G. Section 02655 Installation of Pipe
H. Section 02676 Pressure Testing of Piping
I. Section 02940 Revegetation
J. Section 03000 General Concrete Construction
K. Section 03480 Precast Concrete Vaults
L. Section 15058 PVC Pipe and Fittings, Three Inches and Smaller
M. Section 15891 PVC Pipe Vent Systems
N. Section 16890 Fiber Optic Cable and Hardware

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Society for Testing and Materials
   D75 Practice for Sampling Aggregates.
   D1556 Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
D2729  Specification for Poly Sewer Pipe and Fittings.

D4253  Test Methods for Maximum Index Density of Soils Using a Vibration Table.

D4254  Test Methods for Maximum Index Density of Soils and Calculations of Relative Density.

D4632  Test Methods for Grab Breaking Load and Elongation of Geotextiles.

F405   Specification for Corrugated Polyethylene Tubing and Fittings.

B. State of California, Department of Transportation, Manual of Test Volumes 1-2-3 (Standard Test Methods)

Test 417 - Testing Soils and Waters for Sulfate Content.

Test 422 - Testing Soils and Waters for Chloride Content.

Test 643 - Laboratory Method of Determining Minimum Resistivity.

C. San Diego Area Regional Standard Drawings

D. Standard Specifications for Public Works Construction

1.04  SUBMITTALS

A. Drawings, sections and supporting calculations for sheeting, shoring, bracing, sloping or other means to provide worker protection during excavation and trenching operations. Provide submittals for each trench section to be constructed and indicate the anticipated locations and lengths for each trench section.

B. Methods, schedule and equipment to be used for earthwork activities.

C. Six copies of a report from a testing laboratory verifying that all materials conform to the requirements specified and are asbestos free.


E. Potholing Report.

1.05  PLAN FOR SHORING, BRACING OR SLOPING OF TRENCHES

A. All excavations shall be protected in a manner as set forth in the rules, orders and regulations of the Construction Safety Orders issued by the Division of Industrial Safety. Drawings showing the method of worker protection shall comply with CALOSHA. If, however, such drawings do not comply with CALOSHA, an alternative drawing prepared and signed by a civil or structural engineer registered in the State of California shall be submitted to the Engineer prior to any excavation certifying that the drawing is not less effective than the shoring, bracing, sloping, or other provisions of the Safety Orders.

B. If the Contractor's trench protection system includes the use of a shield, the shield design shall be approved by the Division of Industrial Safety. Structural details shall indicate the maximum pressure the shield can withstand, the trench configuration and supporting calculations indicating the maximum pressure against the shield. In portions of the trench near existing facilities, use sheeting or other acceptable methods in lieu of a shield.

C. Include on the detailed drawing showing the shoring, bracing, sloping and other provisions surcharge loads for nearby embankments and structures, for spoil banks, and for construction equipment and other construction loadings. Indicate on the drawing for all trench conditions the minimum horizontal distances from the side of the trench at its top to the near side of the surcharge loads.
D. Nothing contained in this section shall be construed as relieving the Contractor of the full responsibility for providing shoring, bracing, sloping, or other provisions which are adequate for worker protection.

1.06 FIELD QUALITY CONTROL

A. Sampling and testing methods used by the Engineer to determine the performance or lack of performance of backfill materials shall not relieve the Contractor from his responsibilities for compliance with the contract documents.

B. The following sampling and testing methods will be used by the Engineer:

1. Determination of soil density in place by the sand cone method, ASTM D1556.

2. Determination of laboratory moisture density relations of soils by ASTM D1557.

3. Determination of the relative density of cohesionless soils by ASTM D4253 and D4254.

4. Sampling of backfill materials by ASTM D75.

C. The Engineer shall determine how many, and from where, the test samples shall be obtained.

D. Provide the Engineer a minimum 24 hours advance notice of any work which will require testing and sampling as specified herein. The cost to the Water Authority associated with any testing, sampling, and inspection scheduled by the Engineer on account of the advance notice provided by the Contractor that is delayed or prevented from occurring on the scheduled day due to insufficient progress or other fault of the Contractor, shall be backcharged to the Contractor and deducted from future partial or final payments.

E. Allot sufficient time during construction for the performance of any quality control testing deemed necessary by the Engineer. Permit the Engineer to make field density tests of any compacted backfill layer prior to placing additional backfill material.

F. Any test falling below the specified relative compaction shall be deemed non-compliant with the specifications. Rework the entire area between locations that have passed until all tests in the area meet the specified relative compaction.

G. The Contractor shall be backcharged the cost of retesting failing tests, including the initial retest. Such backcharges shall be deducted from future partial or final payments.

H. Reference to soil classification types shall be pursuant to the Unified Soil Classification System.

1.07 DEFINITIONS

A. PAVEMENT ZONE. The pavement zone is defined as the asphalt concrete and aggregate base pavement section, or the concrete flatwork and aggregate base areas, placed over the trench backfill.

B. STREET ZONE. The street zone is defined as the top 30 inches of the trench immediately below the pavement zone.

C. TRENCH ZONE. The trench zone is defined as the portion of the trench from the top of the pipe zone to the bottom of the street zone in paved areas or to the existing surface in unpaved areas.

D. PIPE ZONE. The pipe zone is defined as the full width of trench from the bottom of the pipe or conduit to a horizontal level above the top of the pipe. Thickness of pipe zone above the top of the pipe shall be 12 inches unless otherwise shown in the contract documents for the particular type of pipe installed. Where multiple pipes or conduits are placed in the same trench, extend the pipe zone from the bottom of the lowest pipe to a horizontal level 12 inches above the top of the highest pipe unless otherwise shown in the contract documents.
E. PIPE BEDDING ZONE. The pipe bedding zone is defined as a layer of material immediately below the bottom of the pipe or conduit and extending over the full trench width on which the pipe is bedded. Thickness of pipe bedding zone shall be 12 inches unless otherwise shown in the contract documents for the particular type of pipe installed.

PART 2 - MATERIALS

2.01 EARTH BACKFILL

A. Earth backfill is defined as material removed from the required excavations and used as backfill or earth fill. Earth backfill that meets the requirements specified herein may be used for all backfill or fill, except where imported materials are shown on the Plans or specified herein. Do not use stockpiled topsoil for backfill or fill.

B. Earth backfill shall be excavated material that is free from organic matter, roots, debris, and rocks larger than six inches in the greatest dimension.

C. Earth backfill used in the trench zone shall be native granular materials free from roots, debris, and organic matter with less than 50 percent passing the No. 200 sieve and with no more than 60 percent gravel (i.e., not less than 40 percent passing the No. 4 sieve) and rock particles with a maximum dimension no greater than six inches.

D. Where the onsite materials are determined by the Engineer to be unsuitable, imported fill shall be provided by the Contractor.

2.02 STRUCTURAL BACKFILL

A. Material for structural backfill shall be free from clay balls and shall have a sand equivalent greater than 30 per ASTM D2419 with the following gradation:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing By Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 inch</td>
<td>100</td>
</tr>
<tr>
<td>1/2 inch</td>
<td>95 - 100</td>
</tr>
<tr>
<td>3/8 inch</td>
<td>50 - 100</td>
</tr>
<tr>
<td>No. 4</td>
<td>20 - 65</td>
</tr>
<tr>
<td>No. 8</td>
<td>10 - 40</td>
</tr>
<tr>
<td>No. 40</td>
<td>0 - 20</td>
</tr>
<tr>
<td>No. 100</td>
<td>0 - 5</td>
</tr>
</tbody>
</table>

B. Excavated material may be used for structural backfill provided it conforms to the specification for structural backfill.

2.03 IMPORTED SAND

A. Imported sand shall be free from clay balls, organic matter, and other deleterious substances and shall have a coefficient of permeability greater than 0.014 measured in accordance with ASTM D2434 or a sand equivalent of greater than 30 per ASTM D2419. Resistivity for imported sand shall be not less than 2,000 ohm cm when measured in accordance with California Test Method 643. Imported sand shall not exceed a maximum chloride concentration of 200 mg/l when measured in accordance with California Test Method 422 and a maximum sulfate concentration of 500 mg/l when measured in accordance with California Test Method 417.
B. Imported sand shall conform to the following gradation:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing By Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 inch</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>75 - 100</td>
</tr>
<tr>
<td>No. 16</td>
<td>35 - 75</td>
</tr>
<tr>
<td>No. 50</td>
<td>10 - 40</td>
</tr>
<tr>
<td>No. 200</td>
<td>0 - 10</td>
</tr>
</tbody>
</table>

C. If the Contractor elects to use imported sand in the pipe and pipe bedding zones, the entire pipe zone and pipe bedding zone shall be backfilled with the same material placed at the same relative compaction.

2.04 CRUSHED ROCK

A. Crushed rock shall contain less than 1 percent asbestos by weight or volume and shall conform to the SSPWC, Section 200-1.2, for 3/4 inch crushed rock gradation, as follows:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing By Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 inch</td>
<td>100</td>
</tr>
<tr>
<td>3/4 inch</td>
<td>90 - 100</td>
</tr>
<tr>
<td>1/2 inch</td>
<td>30 - 60</td>
</tr>
<tr>
<td>3/8 inch</td>
<td>0 - 20</td>
</tr>
<tr>
<td>No. 4</td>
<td>0 - 5</td>
</tr>
</tbody>
</table>

B. If the Contractor elects to use gravel or crushed rock in the pipe and pipe bedding zones, the entire pipe zone and pipe bedding zone shall be backfilled with the same material placed at the same relative density.

2.05 PERMEABLE MATERIAL

A. Permeable material shall consist of hard, durable, clean sand, gravel, or crushed stone and shall be free of asbestos, organic material, clay balls or other deleterious substances. Durability Index shall be at least 40 per California Test Method No. 229. Gradation shall be:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing By Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 inch</td>
<td>100</td>
</tr>
<tr>
<td>1/2 inch</td>
<td>95 - 100</td>
</tr>
<tr>
<td>3/8 inch</td>
<td>70 - 100</td>
</tr>
<tr>
<td>No. 4</td>
<td>0 - 55</td>
</tr>
<tr>
<td>No. 8</td>
<td>0 - 10</td>
</tr>
<tr>
<td>No. 200</td>
<td>0 - 3</td>
</tr>
</tbody>
</table>

2.06 ROCK REFILL

A. Rock refill shall be crushed or natural rock containing less than 1 percent asbestos by weight or volume and having the following gradation:
<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing By Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1/2 inch</td>
<td>100</td>
</tr>
<tr>
<td>1 inch</td>
<td>90 - 100</td>
</tr>
<tr>
<td>3/4 inch</td>
<td>30 - 60</td>
</tr>
<tr>
<td>1/2 inch</td>
<td>0 - 20</td>
</tr>
<tr>
<td>3/8 inch</td>
<td>0 - 5</td>
</tr>
</tbody>
</table>

2.07 CEMENT SLURRY OR ALKALIZED SAND BACKFILL

A. Cement slurry backfill, where shown on the Plans, shall consist of 1 1/2 sack (94 pounds) Type II Portland cement added per cubic yard of imported sand, except within six inches of a buried flexible pipe coupling, in which case use 1/2 sack (25 pounds) hydrated lime added per cubic yard of imported sand.

2.08 RIP-RAP

A. Stone for rip-rap energy dissipator shall be in accordance with Section 200-1.6 of the SSPWC. Placement of rip-rap energy dissipator shall be in accordance with SDARSD D-40. Rock class shall be 1/4 ton, or as indicated on the Plans. Rip-rap thickness, “T,” shall be 2-1/2 feet for 1/4 ton rock.

B. Rip-rap shall rest atop filter material consisting of a minimum six-inch layer of 3/4 inch crushed rock and filter fabric as specified herein. The filter fabric shall be placed against a compacted excavated subgrade. Crushed rock shall be placed and compacted atop the filter fabric. Placement of rip-rap by dumping will not be permitted.

2.09 WATER FOR COMPACTION

A. Water shall be free of organic materials and have a pH of 7.0 to 9.0, a maximum chloride concentration of 500 mg/l when tested by California Test Method 422, and a maximum sulfate concentration of 500 mg/l when tested by California Test Method 417.

2.10 FILTER FABRIC

A. Filter fabric will be manufactured from polyester, nylon, or polypropylene material; will be of nonwoven construction; and will meet the following requirements:

1. Grab tensile strength (ASTM D4632): 100 lbs. minimum for a one inch grip.

2. Equivalent open sizes (COE CW-02215): Size to retain the largest 15 percent particle sizes of the soil to be retained.

B. Filter fabric will be MIRAFI manufactured by Mirafi Inc., Charlotte, North Carolina, or equal.

2.11 CORRUGATED POLYETHYLENE TUBING

A. Tubing shall be nonperforated conforming to ASTM F405.

2.12 PERFORATED UNDERDRAIN PIPE AND FITTINGS (PVC-Underdrain)

A. Materials shall conform to ASTM D1784, Class 12454-B or 12454-C.

B. Pipe shall be perforated PVC sewer pipe and drainpipe conforming to ASTM D2729.
C. Perforations shall be two rows of 1/2 inch diameter holes, five inches on centers, with rows separated by 120 degrees of arc centered at pipe bottom.

D. Fittings and couplings shall be nonperforated fittings conforming to ASTM D2729.

2.13 FILTER BEDS FOR UNDERDRAINS

A. Use 3/4-inch crushed rock as specified herein in conjunction with an outer envelope of filter fabric to form a permeable encasement around the perforated underdrain piping.

PART 3 - EXECUTION

3.01 GENERAL

A. Sufficient earthwork material to complete the work may not be available at the site. Secure material, as necessary, and required permits to complete the project requirements.

B. Access to the site will be over public roads and restricted to only those private roads shown on the Plans. Exercise care in the use of such roads and repair any damage caused thereto. Such repair shall be to the satisfaction of the owner or agency having jurisdiction over the road. Take whatever means necessary to prevent damage and tracking of mud onto the existing roads and keep roads free of debris.

C. Prevent dust from damaging crops, orchards, cultivated fields, and dwellings, or causing a nuisance to persons. Dust control measures shall be in effect for the duration of the project.

D. The transportation, use and storage of all vehicles, equipment, materials, supplies and other items used in the work shall comply with Section 01530, Protection of Existing Facilities.

E. Immediately dispose of excavated materials unsuitable for backfill. Excavated materials suitable for backfill may be stored at the site and shaped so as not to interfere with public traffic or to mix with other stockpiled material.

F. Provide and operate equipment to keep excavations and trenches free of water in accordance with Section 02140, Dewatering.

G. Provide adequate facilities for drainage of water from stockpiled excavated material and adequate facilities for handling of storm drainage from the storage area.

H. Place temporary pavement or first lift of permanent pavement on trenches in existing streets within 24 hours after the trench has been backfilled and compacted, unless otherwise approved by the Engineer. Maintain temporary pavement until permanent pavement is placed.

3.02 SUPPORT OF EXCAVATIONS

A. Take necessary measures to protect excavations and adjacent improvements from running, caving, boiling, settling, or sliding soil resulting from high groundwater table, surcharge, or other problems associated with the soil excavated.

B. Install shoring, sheeting and bracing for trench and structure excavation progressively with the removal of excavated material. Erect sheeting or lagging to exclude groundwater and prevent fines from migrating into the excavation. In soft, wet ground, drive sheeting to a lower elevation level as excavation progresses so that sheeting is embedded in undisturbed earth. Bracing or sheet piling may be permitted to penetrate structural concrete only as approved in advance by the Engineer.

C. The support for excavation shall remain in place until the pipeline or structure has been completed. During the backfilling of the pipeline or structure, the shoring, sheeting and bracing shall be carefully removed so no voids shall be created and no caving, lateral movement or flowing of the subsoils shall occur.
D. Withdraw the sheeting and bracing members as the backfill is raised, maintaining sufficient support to protect the work and workers. Remove bracing completely. Where unstable conditions may occur in the underlying strata, and withdrawal of the excavation support system may endanger the work, portions of the sheeting and bracing, including pressure treated lagging, may be left in place with approval of the Engineer. Remove all wood within a zone extending five feet below finished grade.

E. Any damage resulting from improper installation or inadequate maintenance shall be the responsibility of the Contractor.

3.03 EXCAVATION

A. Excavation is unclassified. Perform all excavation regardless of the type, nature, or condition of the material encountered to accomplish the work. Do not operate excavation equipment within five feet of existing structures or newly completed construction. Accomplish excavation in these areas with hand tools.

B. Where trenching or excavation occurs in paved areas, sawcut the pavement, regardless of the thickness, and curbs, gutters, and sidewalks prior to excavation of the trenches with a pavement saw or pavement cutter. Width and depth of the pavement cut shall be in accordance with the SSPWC. Remove and dispose of pavement and concrete materials off the site in accordance with local regulations. Do not use for backfill.

C. Perform excavation for structures to the dimensions and grades indicated. Excavate to such width outside the lines of the structure to be constructed as may be required for proper working methods, the erection of forms, and the protection of the work.

D. Compact subgrade until the top 12 inches are compacted to 90 percent relative compaction. Fill holes and depressions to the required line, grade, and cross sections with structural backfill or other material approved by the Engineer. The finished subgrade shall be within a tolerance of plus or minus 0.10 of a foot of the grade and cross section indicated, shall be smooth and free from irregularities, and shall be at the specified relative compaction. The subgrade shall be considered to extend over the full width and extend one foot beyond the edge of the foundations.

E. Notify the Engineer when structure excavation is complete. Do not place forms, reinforcing steel, concrete, or precast structure until the excavated area has been inspected by the Engineer.

3.04 TRENCH EXCAVATION

A. Construct the trench to the grades as shown on the Plans and in accordance with the plan for shoring, bracing, or sloping of trenches. Accurately grade the bottom of the trenches to provide uniform bearing and support for each section of the pipe or conduit at every point along its entire length, except for the portions of the pipe sections where it is necessary to excavate for pipe bells and pipe slings. In order that the pipe rests on the bedding for as nearly its full length as practicable, bell holes and depressions shall be only of such length, depth and width as required for properly completing the joint. Remove stones and hard objects protruding above grade as necessary to avoid point bearing.

B. Where earth fills or embankments are required to cover the pipe, construct and compact the fill to an elevation of one-foot minimum greater than the top of the largest pipe or conduit to be installed. Excavate trench in the newly compacted fill or embankment. Compact backfill above the pipe zone to the same relative compaction as the original fill or embankment.

C. The material excavated from unshored trenches may be temporarily placed alongside the trench beyond a one horizontal to one vertical plane drawn upward from the lower of the base of excavation. Do not obstruct drainage courses, roadways or streets.

3.05 TRENCH WIDTHS

A. When using mechanical compaction methods, both maximum and minimum trench widths in the pipe zone shall be as shown on the Plans, except the maximum width may be increased as necessary for sheeting and
bracing and for the proper performance of the work. Notify the Engineer if the trench width exceeds the maximum allowable width for any reason.

B. Trench width at the top of the trench shall not be limited, except where the width of excavation would undercut or endanger adjacent structures, utilities and footings, or exceed the rights of way provided for the work. In such case, width of trench shall be such that there is at least 18 inches between the top edge of the trench and the structure, utility or footing.

3.06 LENGTH OF OPEN TRENCH

A. Unless otherwise authorized in writing by the Engineer, limit the length of open trench to 1,200 feet per bid schedule in paved areas and to 4,000 feet per bid schedule in all other areas. Open trench length shall be defined as the point from where the initial excavation is occurring to the point where backfill to existing grade is complete.

3.07 OVER-EXCAVATION

A. After the required excavation has been completed, the Engineer will inspect the exposed subgrade to determine the need for any additional excavation. Conduct over-excavation to the depth and as directed by the Engineer in all areas where unsuitable materials exist at the exposed subgrade and replace with structural backfill, rock refill or other suitable material approved by the Engineer.

B. Over-excavation shall include the removal of all such unsuitable material that exists directly beneath the influence of the pipeline or structure and within a zone outside and below the structure defined by a line sloping at one horizontal to one vertical from one foot outside the edge of the structure footing.

C. Payment for over-excavation directed by the Engineer will be made in accordance with unit price bid items for over-excavation or as extra work. Payment for over-excavation during trench excavation will be made for the area which is located directly below the allowable trench width as shown on the Plans.

D. No additional payments will be made for over-excavation and placement of structural backfill, rock refill or other suitable material not directed by the Engineer. No compensation shall be made for over-excavation and placement of such material for the Contractor's convenience.

3.08 PLACING AND COMPACTING FILL

A. Remove form materials and trash from the excavation before placing any fill material.

B. Remove uncompacted fill, loose and disturbed soils until firm soils or formational material are exposed. The removed materials may be used as compacted fill provided they are free of deleterious materials.

C. Scarify the exposed surface to a depth of six inches, moisture condition to within 2 percent of optimum moisture content, and compact to at least 90 percent relative compaction. Obtain approval from the Engineer of the exposed surface before placement of fill.

D. Add water to the backfill material or dry the material as necessary to obtain a moisture content within 2 percent of optimum. Obtain a uniform moisture content throughout the material of each layer being compacted.

E. If the backfill material becomes saturated from rains or any other source, remove and replace the unsatisfactory material with suitable material compacted to the specified density. No additional payment will be made for removal and replacement of unsatisfactory material.

F. Where fill is to be constructed on slopes steeper than five to one, excavate an equipment width keyway beneath the toe at the base of the fill. The keyway will have a minimum width of ten feet and slope at least 2 percent into the slope. Continue benching into competent material as the fill progresses up slope. All benching shall be approved by the Engineer.
G. Place subdrain in all fills in excess of five feet, consisting of PVC perforated underdrain pipe or corrugated polyethylene drainage tubing on a six-inch filter bed. Backfill with minimum three cubic feet of filter material per lineal foot of drain.

H. Place fill in six- to eight-inch lifts, brought to within 2 percent of optimum moisture content, and compacted to at least 90 percent relative compaction. Do not place rocks larger than six inches in maximum dimension in the fills.

I. Provide special attention to compaction along the top and outer edge of the fill slope during construction. Backroll fill slopes after each fill lift is completed. Perform additional rolling and trimming as may be required at the finish of the slope construction to correct local surficial slumping.

3.09 PLACING AND COMPACTING STRUCTURAL BACKFILL

A. Place structural backfill material around structures, channels, vaults, manholes, and other structures to a minimum distance of five feet from the outside structure surface, or to the limits shown on the Plans. Do not exceed loose lifts of eight inches. Compact each lift to 95 percent relative compaction. Stop structural backfill 12 inches below finished grade in areas where topsoil is to be replaced.

B. Do not operate earthmoving equipment within five feet of any concrete structure. Backfill shall not be placed until the concrete has developed to at least 75 percent of the 28-day compressive strength, and in all cases not less than 48 hours after the last pour. Place and compact fill or backfill adjacent to concrete structures with hand-operated tampers, roller wheels, or other equipment that shall not damage the structure.

3.10 TRENCH BACKFILL AND COMPACTION

A. Unless otherwise shown in the Plans or otherwise described in the specifications for the particular type of pipe installed, relative compaction in pipe trenches shall be as follows:

1. Pipe zone and pipe bedding zone - 90 percent relative compaction.
2. Trench zone - 90 percent relative compaction.
3. Street zone - 95 percent relative compaction.
4. Rock refill for foundation stabilization - 80 percent relative density.
5. Rock refill for overexcavation - 80 percent relative density.

B. Unless otherwise indicated, use crushed rock or imported sand for pipe bedding and pipe zone materials.

C. Place bedding and backfill materials true to the lines, grades, and cross-sections indicated on the Plans and compacted to the degree specified herein. Place bedding and backfill materials in horizontal uncompacted lifts not exceeding eight inches in thickness. The difference in level on either side of a pipe shall not exceed 12 inches.

D. If the material for the pipe zone and pipe bedding consists primarily of gravel or crushed rock, provide a filter fabric between the gravel or crushed rock and the material being used as backfill in the trench zone and on the sides of the pipe and pipe bedding zones between the native material and the gravel or crushed rock to prevent migration of fines. Filter fabric shall not be required where sand is used as the backfill material in the pipe zone and pipe bedding zone, unless directed by the Engineer. Filter fabric shall be overlapped a minimum of one foot.

E. Protect the pipe from damage during construction. Replace or repair broken or damaged pipe or pipe coatings. For tamping of backfill over the pipe, use tampers, vibratory rollers, and other equipment that shall not injure or disturb the pipe. Carefully place backfill around and over the pipe and do not allow it to fall directly upon the pipe. Place backfill material carefully and evenly onto the backfill previously placed in the pipe zone to prevent lateral movement of the pipe. Do not permit free fall of the material until at least
two feet of cover is provided over the top of the pipe. Do not drop sharp, heavy pieces of material directly onto the pipe or the tamped material around the pipe.

F. Backfilling of the trench above the pipe zone shall not proceed until the required compaction in the pipe zone has been tested, verified and accepted by the Engineer.

G. Compact material placed within 12 inches of the outer surface of the pipe by hand tamping only.

H. Do not allow construction traffic nor highway traffic over the pipe trench until the trench backfill has been compacted and brought back even with existing adjacent grade.

I. At each pipeline closure lap joint, backfill the exposed portion of the pipe within the pipe zone and pipe bedding zone with cement slurry. Remove pipe bedding material at the closure lap joint a minimum of two feet each side of the joint to ensure placement of the cement slurry on native ground. Place cement slurry after completing the backfill on either side of the closure lap joint.

3.11 ALTERNATIVE TRENCH BACKFILL METHODS

A. At the Contractor's option one or more procedures for the placement of backfill to achieve the required compaction may be submitted to the Engineer. Clearly identify the proposed material, equipment, maximum lift thickness, and number of passes of the compaction equipment to obtain the necessary compaction.

B. At the beginning of the project, prepare a test section using the proposed compaction equipment and backfill material to experiment with each backfill procedure. Do not commence with backfill operations until one backfill procedure has been selected and accepted by the Engineer.

C. Limit the maximum lift height to 1/2 of the pipeline diameter. Periodic monitoring and testing will be performed by the Engineer to determine that the requirements of the specification are being met. Proposed changes in methods and/or materials shall be retested as provided herein.

3.12 HYDRAULIC CONSOLIDATION AND VIBRATION

A. Compaction by hydraulic consolidation or jetting and vibration shall be permitted when, as determined by the Engineer, the material is of such character that it shall be self-draining when compacted, that foundation materials shall not soften or be otherwise damaged by the applied water, and no damage from hydrostatic pressure shall result. No sluicing or flooding of backfill material will be allowed.

B. Prior to compaction by hydraulic consolidation, submit procedures, proposed material, equipment, maximum lift thickness, methods of removing excess water, and prepare a test section using the proposed procedure. Include methods to prevent the removal of fines from the backfill material and to prevent the creation of voids. Do not commence with hydraulic consolidation operations until the procedure has been accepted by the Engineer. Periodic monitoring and testing will be performed by the Engineer to determine that the requirements of the specification are being met. Retest each proposed change in methods and/or change in materials.

C. When hydraulic consolidation and vibration is permitted, place and compact the washed sand in layers not exceeding four feet in thickness. Water jets shall be of sufficient length to extend to the bottom of each layer. Operate the jets with sufficient water pressure to settle the backfill thoroughly.

D. The material shall be settled to the satisfaction of the Engineer throughout the length and depth of each layer before discontinuing operations on said layer. Each previously placed layer shall have drained and shall be unyielding, as determined by the Engineer, before placing subsequent layers thereon.

E. Where natural drainage fails to remove excess water from the soil as required to achieve the specified compacted density, remove the excess water by pumping.
3.13 PLACING CEMENT SLURRY

A. Provide batching equipment to obtain the proper weights of sand, cement, water and admixtures. The cement slurry as discharged from the mixer must be uniform in composition and consistency throughout each batch. On slopes, a stiffer mix of cement slurry may be required. In such cases, use vibration to ensure the cement slurry completely fills all spaces.

B. The pipe may be supported on rock bags or sand bags so that the cement slurry flows under the pipe until the slurry appears on the other side. Where required to prevent uplift, place the cement slurry in two stages, allowing sufficient time for the initial set of the first stage before the remainder is placed.

C. Do not place backfill above the pipe until the cement slurry has reached the initial set. If backfill is not placed over the cement slurry within eight hours, place a six-inch minimum cover of moist backfill over the cement slurry.

3.14 SITE GRADING

A. Perform earthwork to the lines and grades shown on the Plans. Shape, trim, and finish slopes to conform with the lines, grades, and cross sections as shown. Remove exposed roots and loose rocks exceeding three inches in diameter. Round tops of banks to smooth curves to not less than a six-foot radius. Neatly and smoothly trim rounded surfaces. Over-excavation and backfilling to achieve the proper grade shall not be permitted.

B. Shape, trim and finish slopes around structures as shown on the Plans. Maintain a 2 percent grade away from all structures for a minimum of three feet all around. Grade a ten foot wide access pad adjacent to all new manway structures and valve vaults. Provide positive drainage away from all structures.

C. Maintain temporary construction roads in a safe condition free from rock, boulders, roots, ruts, or other debris which impairs normal use.

3.15 TOPSOIL REPLACEMENT

A. Replace topsoil after completion of backfilling, compaction and site grading. With the exception of permanent access roads and structures, replace topsoil in the same areas and to the same depth from where the topsoil was originally removed. Pursuant to Section 02110, Clearing and Grubbing, import topsoil, as required, to meet the replacement requirement.

B. Spread the salvaged topsoil over all specified areas at a uniform depth. Unify the topsoil with surface soils by scarifying the compacted surface perpendicular to the slope to a depth of 12 inches using rippers spaced 12 inches apart. Do not operate equipment on or otherwise recompact scarified surfaces.

3.16 DISPOSAL OF EXCESS MATERIALS

A. Immediately dispose of unsuitable excavated material. No prearranged disposal site or related permits have been determined or secured. Obtain written permission and/or permit(s) from the property owner(s) where excess or unsuitable material will be disposed.

B. Obtain a release from individual property owner(s) absolving the Water Authority from any and all responsibility in connection with the disposal of such material. Provide the Engineer with two copies of each release and permit.

C. Haul excavated materials from the work site to approved disposal location(s) during the hours permitted in accordance with local traffic control regulations. Provide traffic control as required by the agency having jurisdiction. Material may be stockpiled temporarily at locations on the work site if approved in writing by the Engineer.
3.17  RESTORATION

A. Grade the right of way to the contours of the original ground and match the adjacent undisturbed ground. Make surfaces free of all cleared vegetation, rubbish, and other construction wastes. Dispose of all excess excavation, surface rocks and spoil.

B. Replace curbs, gutters, sidewalks, asphalt and paving as shown on the Plans or in conformance with the requirements of the agency having jurisdiction. When there is no agency requirements, replace asphalt and paving in conformance with the SSPWC.

END OF SECTION
SECTION 02229 - BLASTING

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section describes the methods, limitations, and reporting requirements for the use of explosives and blasting conducted during excavation and tunneling operations.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02200 Earthwork
B. Section 02310 Tunneling
C. Section 02315 Portal Area Development

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. California Code of Regulations, Title 8, Subchapter 20, Tunnel Safety Orders.
B. Occupational Safety and Health Administration Regulations (Standards-29 CFR) Standard 1926, Subpart U, Blasting and Use of Explosives.

1.04 SUBMITTALS

A. Copies of required blasting permits.
B. A two-part conceptual blasting plan prior to the start of drilling. Submit additional reports on blasting operations as specified herein. The conceptual blasting report shall be as follows:

1. Part 1 - General Plan: The General Plan shall include a complete summary of proposed methods for transporting, handling, storage, and use of explosives. The plan shall include a description of the experience record of the responsible blaster and copies of his California blasting license and his San Diego County Explosives Permit. The plan shall include the approval of the Chief of the San Diego County Fire Department and the Sheriff of San Diego County. The plan shall include copies of approved noise variances issued by local jurisdictions.

2. Part 2 - Site Specific Plan: The Site Specific Plan shall include the proposed general concept for trench excavation blasting, including controlled blasting techniques and control and monitoring of fly rock, airblast and ground vibration. Blasting intensities shall be limited as required to prevent damage to all existing structures, and in no case, shall intensities exceed the safety standard of particle velocity recommended by the U.S. Bureau of Mines. Provision shall be made for one or more test blasts. Samples of the proposed daily blasting report and the daily seismographic monitoring report shall be included in the plan submittal. The Site Specific Plan shall also contain samples of forms to be used for Blasting Notification (blasting notification includes notification to owner), Preblast Inspection, Blasting Complaint Form, Preblast Inspection Waiver Form, and Procedure for Handling Blasting-Related Complaints.

C. Seismic monitoring procedure.

D. Submit qualifications of the blasting consultant meeting the quality assurance requirements specified herein. Submit qualifications for the registered civil or geotechnical engineer, or a certified engineering geologist, or a State of California registered geophysicist; preblast inspector; seismic monitoring inspector; and blasting inspector.
1.05 QUALITY ASSURANCE

A. Retain the services of a qualified blasting consultant specialist to assist in the preparation of the required blasting plans and verification of reports. The blasting consultant’s staff shall include:

1. A registered civil or geotechnical engineer or a certified engineering geologist or a State of California registered geophysicist with a minimum five years of recent experience in supervising the loading and firing of charges for rock slopes or tunnel excavations.

2. A qualified preblast inspector specializing in preblast surveys, with a minimum of five years experience in the field of preblast inspections.

3. A qualified seismic monitoring inspector specializing in the field of blast vibration monitoring, with a minimum of five years experience in the field of blast vibration monitoring.

4. A blasting inspector to observe all blasting operations, including the loading of drill holes for blasting, to verify that blasting operations are in conformance with approved plans. The minimum qualifications for the blasting inspector would be a State of California Blaster's License, Class B, recognition in the blasting field as an expert in drilling and blasting whose primary source of income is from providing specialized blasting and/or blasting consultant services.

B. The blasting consultant shall not be an employee of, nor be affiliated with, any explosives manufacturer, explosives distributor, or the Contractor. Should the Engineer determine during the course of the work, that the blasting consultant is not performing as required, retain the services of a different blasting consultant with qualifications satisfactory to the Engineer at no additional cost to the Water Authority.

C. The Engineer's review of the Contractor's blasting plans shall not relieve the Contractor of any of his responsibilities under the Contract for assuring the complete safety of his operation with respect to adjacent improvements and so as to not aggravate existing structural conditions or cause damage or for the successful completion of the work in conformity with the requirements of the Contract Documents. Blasting plan review shall not operate to waive any of the requirements of the Contract Documents nor relieve the Contractor of any regulation, permit obligation or condition therein. Graduation from an accredited four year college with a degree in engineering, geology, or equivalent, and demonstrated ten years recent blasting project experience in supervising the loading and firing of charges for rock slopes or tunnel excavations may be substituted for professional registration and/or certification at the discretion of the Engineer.

PART 2 - MATERIALS

2.01 MATERIALS AND EQUIPMENT

A. Furnish materials and equipment as required for blasting operations. Material usage, including transportation and storage, shall conform to all applicable regulatory agency requirements.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

A. No blasting shall be permitted which, in the Engineer's judgment, may be detrimental to existing installations, including the Water Authority's existing and under construction pipelines, structures, and all other related facilities.

B. Do not perform drilling or blasting work until the Contractor's plan for blasting operations has been submitted to and accepted by the Engineer. Limit blasting intensities as required to prevent damage to existing structures and utilities. Do not allow intensities to exceed the safety standards of particle velocity/frequency established by the U.S. Bureau of Mines (RI8507).

C. Prior to blasting, obtain the blasting permits/licenses required by City of San Diego, San Diego County, the State of California, and any other agency having jurisdiction. The San Diego County blasting ordinance and
local city ordinances typically contains several project-specific conditions which affect the cost of the work. Investigate these conditions during bid proposal preparation.

D. Conform to the requirements specified in the State of California Construction Safety Orders for the transporting, handling, storage, and use of explosives. Transportation of explosives shall be in accordance with the regulations of the State Fire Marshall and the California Highway Patrol. The locations, access and construction of explosive storage magazines shall be in accordance with the American Table of Distances for Storage of Explosives and approved by the Chief of San Diego County Fire Department and the Sheriff of San Diego County.

E. Blasting shall only be permitted between the hours of 8:00 a.m. and 4:00 p.m. during any weekday (Monday through Friday), unless special circumstances warrant another time or day, and special approval is granted in writing by the Engineer and the agency having jurisdiction. Submit any special approvals to the Engineer.

3.02 REPORTING AND NOTIFICATION

A. No blasting shall be permitted until the Contractor receives notification in writing from the Engineer that the blasting plans have been reviewed and until all preblast inspections and reports have been completed.

B. Provide a Blast Plan to the Engineer at least two work days prior to any proposed blast. The Blast Plan shall include explosives loading, distribution, delay periods, maximum pounds of explosives detonated per delay period, blast location, time of blast, distance to nearest improvement, identification of improvement and other blast parameters which are typically included for quality control and construction record purposes. The Blast Plan shall include a written plan describing the proposed seismic monitoring procedure, location, instrumentation, and testing agency. If two work days advance notice is not provided, blasting may be suspended by the Engineer.

C. Notify the Engineer at least two work days in advance of his intention to perform blasting within 400 feet of a residence or commercial building, including Water Authority facilities.

D. Provide a minimum of two working days advance notice in writing to all residences or businesses within 400 feet of the blast area. Provide two-work days notice to all utility agencies whose facilities may be influenced by the blasting operation. Provide the Engineer with a list of all people and agencies notified. Contact Underground Service Alert (USALERT/ DIGALERT) as required by State Law. Determine the blasting notification requirements of the owner and devise a procedure to provide the requested notifications.

E. Submit a blasting report within two-work days following a blast. Provide actual values of explosives loading, distribution, delay periods, maximum pounds of explosives detonated per delay period, blast location, time of blast, distance to nearest improvement, identification of improvements and other blast parameters which are typically included for quality control and construction record purposes. The blast report shall also include results from seismic monitoring performed by the Seismic Monitoring Expert. Seismic monitoring shall be conducted under the supervision of the blasting consultant. Seismic monitoring reports are to include identification of the instrumentation, monitoring location, frequency of the ground motion, peak particle velocity, displacement, airblast, recorded waveforms, date and time, and other relevant data. The blasting and seismic monitoring reports are to be in the format contained in the blasting plan. The blasting consultant shall verify the Contractor's blasting report and seismographic reports prior to submission to the Engineer.

3.03 INSPECTION REQUIREMENTS

A. Conduct preblast inspections of all residential, commercial, and Water Authority structures, and other improvements and facilities as necessary, within 400 feet of the blast area. Preblast inspections are to be conducted by the preblast inspector. Conduct the inspections a minimum of one week and no more than three weeks before blasting operations, unless otherwise approved by the Engineer due to special circumstances. A representative of the Contractor shall accompany the preblast inspector while conducting the inspections. The Contractor shall obtain the permission of the respective building owners prior to conducting the inspection. The Contractor shall arrange for inspection times. The results of the inspection
shall be reviewed by the blasting consultant in order to identify any structural conditions judged to be sensitive to blasting effects. The preblast inspection shall be for the purpose of determining the existence of any visible or reasonably recognizable pre-existing defects or damages in any structure and for quality control and construction record purposes. Visual inspection and photographic documentation methods shall be employed to ensure the validity of information obtained just prior to blasting operations.

B. Complete inspection reports of private property identifying all findings shall be signed by the Contractor, blasting consultant, preblast inspector, and the property owner/occupant. Upon completion of all blasting, the Contractor shall forward all preblast inspection reports and photographs to the Engineer. The inspection reports shall be either typed or recorded on standard 90 minute or microcassette tape.

C. File with the Engineer a summary report of all private property inspections identifying address, occupant/owner's name, time and date of inspections, and any inspection waiver signed by the property owner with an explanation as to why an inspection of a specific structure was not made. This summary and waiver report shall be signed by the Contractor, preblast inspector, and blasting consultant and delivered to the Engineer prior to blasting.

D. Conduct post-blast inspections upon receipt of a written or verbal request or complaint of damage to property, structure, or other improvement from the respective owners. Perform such inspections and provide a written report to the Engineer within 30 calendar days of receipt of the request or complaint.

3.04 BLASTING

A. Drilling and blasting patterns, delay distribution and explosive types and quantities, shall be at the Contractor's option; provided the ground motion frequency and airblast limitations, as specified herein, are met with respect to pounds of explosive detonated per delay period; and provided further that non-nitroglycerin explosive types are used in wet ground conditions. Use only non-electric explosives detonators.

B. Perform blasting with skilled workers and under the direction of a State of California and San Diego County licensed blasting foreman. Perform blasting only when proper precautions have been taken for the protection of people, private property, and existing structures. Injury to people, or damage to private property, or existing structures is the responsibility of the Contractor.

C. As production blasting operations progress, evaluate the drilling and blasting procedures based on the results achieved. If a drilling and blasting program yields unsatisfactory results with regard to excessive blasting effects, the Contractor and Blasting Consultant shall be required to devise and employ methods which shall improve results. The revision may include special methods such as, but not limited to, different delay patterns, adjustment in size of individual blasts, adjustment in diameter of blast holes, closer spacing of blast holes, reduction of the explosives quantity detonated per delay period, or improved stemming procedures, as necessary, to improve results.

D. Conduct controlled blasting in a manner which produces relatively smooth and sound rock faces at the final excavation lines and maintain blasting effects within the prescribed limits. The type, distribution and quantity of explosive detonated per delay period shall be such that existing rock fractures shall neither be opened nor new fractures created outside of the minimum excavation limits. Whenever, in the opinion of the Engineer, further blasting is liable to reduce rock stability or damage pipelines or other structures, cease blasting and continue to excavate the rock by approved mechanical or chemical means. Excessive blasting or "overshooting" shall not be permitted. Fly rock shall be contained within the project rights of way and shall not represent a hazard to people, vehicles, existing improvements or vegetation. Use blasting mats to prevent possible flyrock damage. At the end of each working day, clean the blasting site of all debris associated with the blasting operation. Remove and replace with acceptable material anymaterial outside the authorized cross section which may be shattered or loosened by blasting.

E. Do not permit blasting within 15 feet of an existing pipeline or structure without submission of a site-specific blasting plan to the Engineer and written approval of the plan by the agency having jurisdiction. Do not conduct blasting within 100 feet of concrete which has been placed less than seven calendar days.
3.05 MONITORING REQUIREMENTS AND BLASTING LIMITATIONS

A. Perform seismographic monitoring of all blasting. A seismograph shall be placed at the nearest structure to the blast area to monitor the ground motion particle velocity and frequency during each blast. When blasting adjacent to existing Water Authority pipelines an additional seismograph will be placed over the pipeline at a point closest to the blast area.

B. The maximum particle velocity at the nearest point to the Water Authority pipelines from the blast area shall be six inches per second at a minimum frequency of 10 hertz. In the event either of these limitations are exceeded, the Contractor will perform excavations to determine the extent of possible damage to the pipelines. Perform repair work as necessary and backfill all excavations. The excavation, repair and backfilling will be the sole responsibility of the Contractor whether damage has or has not been incurred.

C. The maximum peak particle velocity at the nearest residential or commercial structure shall be as follows:

<table>
<thead>
<tr>
<th>Frequency (hertz)</th>
<th>Maximum Peak Particle Velocity (inch per second)</th>
</tr>
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<tbody>
<tr>
<td>2.5 to 10</td>
<td>0.5</td>
</tr>
<tr>
<td>11 to 40</td>
<td>0.05 x frequency*</td>
</tr>
<tr>
<td>&gt; 40</td>
<td>2.0</td>
</tr>
</tbody>
</table>

* The maximum allowable peak particle velocity is the product of 0.05 multiplied by the seismogram frequency (e.g., assuming the frequency is 30 Hz., the maximum allowable peak particle velocity is 30 times 0.05 or 1.5 inches per second).

D. Airblast at the nearest residential or commercial building shall not exceed 129 Db-Linear at six hertz high pass system.

3.06 SUSPENSION OF BLASTING

A. Blasting operations may be suspended by the Engineer for any one or more of the following:

1. Safety precautions are inadequate;
2. Ground motion vibration levels exceed specified particle velocity/frequency limits as specified herein;
3. New or further damage to existing structures or improvements as a result of blasting;
4. Blasting methods which in the opinion of the Engineer endanger the stability of intact rock outside of the prescribed limits of excavation;
5. Skilled operators and/or the licensed blasting supervisor is not present;
6. Failure to comply with blasting notification requirements; or
7. Fly rock travels beyond the project right-of-way or strikes overhead lines.

B. Suspension of blasting operations shall not relieve the Contractor of his responsibilities under the terms of the Contract Documents. Do not resume blasting operations until modifications have been made to correct the conditions that resulted in the suspension. The Contractor shall not be entitled to any extension in time, nor to any claim of damage or to excess costs, by reason of any blasting suspension order.

END OF SECTION
 PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes the furnishing, installation, and maintenance of temporary erosion and sedimentation controls for all earthwork, trenching, clearing and grubbing operations.

B. For projects with soil disturbances of one acre or more, comply with the National Pollution Discharge Elimination System General Permit for Storm Water Discharges Associated with Construction Activity, General Permit No. CAS000002 and requirements included herein.

C. For projects with soil disturbances under one acre, erosion and sedimentation control measures shall comply with requirements provided herein, local jurisdictional agency requirements, and applicable requirements in local storm water management programs developed to comply with NPDES permits issued by the Regional Water Quality Control Board.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02110 Clearing and Grubbing

B. Section 02140 Dewatering

C. Section 02200 Earthwork

D. Section 02315 Portal Area Development

E. Section 02510 Access Roads

F. Section 02940 Revegetation

1.03 SUBMITTALS

A. Six copies of a SWPPP prior to commencement of construction in conformance to the requirements for the General Permit. A copy of the General Permit may be obtained from the Water Authority. The SWPPP shall address both storm water and non-storm water discharges.

B. Manufacturers catalog data and samples on materials used for erosion control, including the physical characteristics, application and installation instructions.

C. NOTICE OF INTENT: Submit a Notice of Intent and pay filing fee prior to commencement of construction activities covered by the NPDES General Permit to:

   State Water Resources Control Board  
   Division of Water Quality  
   Storm Water Permit Unit  
   P.O. Box 1977  
   Sacramento, CA  95812

D. NOTICE OF TERMINATION: When construction is complete, submit a Notice of Termination certifying that state and local requirements have been met in accordance the General Permit to:

   San Diego Regional Water Quality Control Board  
   9174 Sky Park Court, Suite 100  
   San Diego, CA  92123
E. RECORDS RETENTION: Retain records of monitoring information, copies of all reports required by the NPDES General Permit, and records of data used to complete the NOI for construction activities covered by the General Permit for at least three years from the date generated. This period may be extended by request from the State Water Resources Control Board and/or San Diego Regional Water Quality Control Board.

F. NONCOMPLIANCE REPORTING: Report instances of noncompliance with the SWPPP to the RWQCB.

PART 2 - MATERIALS

2.01 MATERIALS

A. Provide sand bags, silt fences, straw bales and other materials to control erosion and sedimentation as shown on the SWPPP and Shop Drawings.

PART 3 - EXECUTION

3.01 CONSTRUCTION

A. Construct and implement erosion control measures in accordance with the SWPPP and as described herein.

B. Grade disturbed surfaces to provide positive drainage and prevent ponding of water. Surface water shall be controlled to prevent water damage or deposition of sediment to all adjoining and downstream properties.

C. Install silt fences, sedimentation ponds, sandbag dikes, stabilized construction entrances and any other erosion control measure to minimize sediment escape from the construction site and to maintain runoff quality in compliance with the General Permit. Prevent construction sediment from entering any streams, ponds or drainage facilities.

D. At a minimum, provide erosion and sedimentation control measures immediately following clearing and grubbing operations in the following locations:
   1. In pipeline rights of way immediately upstream of all natural channels.
   2. At the lowest end of areas disturbed by construction before runoff from storms can reach natural streams.
   3. At additional locations as required to control sedimentation as required by the SWPPP.

E. Erosion and sedimentation control measures shall remain in place until such time that the site of work is prepared for permanent drainage and erosion control measures. Remove temporary erosion and sediment control measures so as not to interfere with permanent drainage, erosion control and revegetation.

3.02 MAINTENANCE

A. Conduct site inspections of the erosion and sedimentation control measures prior to forecasted storm events and after the actual storm to evaluate the adequacy and effectiveness of such measures. Make and implement modifications as necessary to comply with the General Permit. Submit inspection reports to the Engineer after each storm event. Include in the inspection reports at a minimum, the date of the inspection, the individual(s) who performed the inspection, the observations, and any modifications implemented.

B. Maintain sedimentation and erosion control measures, ensuring proper operation before, during, and after storm events.
C. Repair all damaged erosion and sedimentation controls. Reinstate to finished condition any erosion damage within the construction area for the duration of the Contract.

D. In accordance with the General Permit, annually certify that the construction activity is in compliance with the requirements of the SWPPP. The certification shall be based upon the site inspections required above. The written certification shall be submitted to the Engineer by each July 1. Immediately notify the Engineer in writing if it is determined, during the annual certification that the construction activity is not or has not been in compliance with any of the General Permit and SWPPP requirements. The notification shall identify the type of noncompliance and include a time schedule when compliance will be achieved.

E. Additional site inspections and/or sampling and analysis may be required at the request of the California Regional Water Quality Control Board, San Diego Region, or the Engineer.

3.03 REMOVAL

A. Remove and dispose of materials used for temporary sedimentation and erosion control measures offsite when permanent erosion control facilities are completed and accepted by the Engineer.

END OF SECTION
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PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes requirements for installing geotechnical instrumentation to monitor ground movements during tunnel excavation. The work includes furnishing a tape extensometer, furnishing and installing convergence points, furnishing blast seismographs, and installing and monitoring survey control points on the ground surface.

B. The Contractor will monitor the instruments, interpret the data obtained, furnish the Engineer with a copy of the data and results, and make modifications to construction procedures if ground movements are found to be excessive.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02310 Tunneling

B. Section 02315 Portal Area Development

1.03 SUBMITTALS

A. Proposed schedule for installation of convergence and survey control points.

B. Manufacturer's literature describing operation and maintenance procedures for the tape extensometer and blast seismographs.

C. Description of convergence and survey control point installation procedures.

D. A detailed drawing indicating the layout and designation of all ground surface survey control points.

E. Description of the proposed methods for monitoring of survey control points.

F. Survey records indicating the elevations of all surface control points on the next day following the readings.

PART 2 - MATERIALS

2.01 CONVERGENCE POINTS

A. Furnish one tape extensometer at least 30 days in advance of commencing tunnel excavation. The tape extensometer shall be Model 1600 manufactured by Geokon, Inc., Lebanon, New Hampshire, or equal.

B. Anchorage points consist of stainless steel eyebolts compatible with the tape extensometer furnished.

2.02 BLAST SEISMOGRAPHS

A. Furnish and maintain a recording seismograph for monitoring blast vibrations. Seismograph shall be Blast-Mate DS-277 manufactured by Instantel Inc., Kanata, Canada, or equal. The seismograph remains the property of the Contractor. The Contractor will maintain the seismograph in operating order including providing rechargeable batteries, accessories, and recording paper as required.

PART 3 - EXECUTION

3.01 GENERAL

A. Provide the Engineer access to instrument locations and assistance required to obtain monitoring data.

B. The Contractor will make convergence measurements during tunnel excavation, and shall monitor peak particle velocities generated by blasting operations. Data shall be available to the Engineer.
C. Perform subsidence monitoring as described herein.

D. The Contractor shall interpret the data and shall make his interpretations available to the Engineer.

3.02 INSTALLATION REQUIREMENTS

A. Convergence Measurements

1. Provide at least 30 percent of the total number of steel ribs installed throughout the tunnel with convergence points. Provide and install an additional 20 convergence point arrays to be installed as required by the Engineer. Install convergence points in the presence of the Engineer and in accordance with approved Shop Drawings.

2. Install convergence points after expanding or blocking steel ribs into place, and before advancing the heading.

3. If it is impracticable to obtain convergence measurements as described herein because of the design of the tunnel, tunneling equipment, the support systems or the accepted method of construction, submit for the review and acceptance of the Engineer alternative methods of measurement.

B. Subsidence Monitoring

1. Establish a system of survey control points on the ground surface for the purpose of monitoring ground subsidence resulting from tunnel excavations as required by the Engineer.

2. Establish survey control point arrays oriented perpendicular to the tunnel centerline at approximately 25-foot intervals. Each array shall consist of five control points: one on the tunnel centerline; two 10 feet on either side; and two 25 feet on either side of tunnel centerline. Review control point locations in the field during construction with the Engineer and modify locations if required.

3. Provide for up to 15 additional survey control points at locations to be determined in the field by the Engineer.

4. Determine the elevation of each survey control point to an accuracy of plus or minus 0.01 foot.

5. Determine the elevation of each control point prior to commencing tunnel excavation and survey each control point at two-day intervals following commencement of tunnel excavation.

6. Continue taking survey readings for a period of two months following completion of tunnel excavation, or as directed by the Engineer.

7. In the event that surface subsidence exceeds one inch, immediately take precautionary measures to prevent further subsidence. Measures shall include:
   a. Provide additional survey control points at more frequent intervals to assess rate of subsidence.
   b. Prepare an action plan, for review by the Engineer, to prevent further subsidence and to restore the ground surface to pre-construction conditions and to repair any damaged utilities or facilities. Obtain written acceptance of restoration plan from the affected owners or authorities, and provide a copy of the agreement to the Engineer.

3.03 INSTRUMENT PROTECTION, MAINTENANCE AND REPAIR

A. Protect the instruments and monitoring equipment from damage. Replace or repair damaged instruments or monitoring equipment prior to continuing tunneling. Discontinue blasting operations as required by the Engineer in the event that blast seismographs for recording blast vibrations are not available.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes requirements for tunnel excavation, initial support, and disposal of excavated material. Tunneling activities shall include, but are not limited to: excavation; handling, removal and disposal of materials encountered in the tunnel; installation of initial support; groundwater control and disposal; ventilation, lighting and electrical; safety facilities; and all other appurtenant work.

B. Determine the excavated size of the tunnel based on tunneling methods, the specified line and grade tolerances, requirements for installing pipeline or other linings, and other limitations as shown on the Plans.

C. The anticipated geologic conditions are described in the Geotechnical Design Summary Report. The GDSR is provided for information only and is not a part of the contract documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02140 Dewatering
B. Section 02229 Blasting
C. Section 02305 Tunnel Instrumentation and Monitoring
D. Section 02315 Portal Area Development
E. Section 02330 Concrete Backfill and Grouting for Tunnels
F. Section 02340 Tunnel Support Systems
G. Section 02655 Installation of Pipe
H. Section 02676 Pressure Testing of Piping

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. California Code of Regulations, Title 8, Subchapter 20, Tunnel Safety Orders.

1.04 DEFINITIONS

A. Soft-Ground Tunneling: Tunnel excavation in earth, boulders, soft decomposed or disintegrated rock, sand, fills, rock fill and other materials which do not require special rock tunneling methods such as blasting or tunnel boring machines.

B. Rock Tunneling: Tunnel excavation which requires the continuous use of rock excavation methods such as: blasting, wedging and barring; or mechanical rock excavating equipment with a tunnel boring machine or roadheader.

C. Mixed-Faced Tunneling: Tunnel excavation through materials that require a combination of soft-ground and rock tunneling methods.

D. Tunnel Initial Support: Elements furnished and installed for temporary support, excavation stability and safety during construction.
E. Presupport: An element of initial support installed ahead of the tunnel face to allow the safe erection of the initial support system. Presupport may consist of spilling, forepoling, crown bars, or rock reinforcement used separately or in combination.

F. Final Lining: Consists of a steel pipe installed in accordance with Section 02655, Installation of Pipe, or other liners as shown on the Plans.

G. A-Line: The line within which no unexcavated material of any kind, and no timber initial support, will be permitted to remain.

H. Controlled Blasting: See Section 02229, Blasting.

I. Smooth Wall Blasting: This technique involves perimeter holes drilled around the excavation limits which are loaded with light distributed charges to remove the final burden and are fired on the last delay of the detonation sequence. The objective is to obtain a smooth wall with minimum overbreak and minimum damage to rock outside the excavation limit.

1.05 QUALITY ASSURANCE

A. Comply with current applicable regulations of federal, state and local agencies. Comply with applicable provisions of Tunnel Safety Orders of the State of California, Division of Industrial Safety, and 29 CFR Part 1926, Subpart S, Underground Construction. In the event of conflict among applicable regulations, comply with the more restrictive applicable regulation.

B. Tunneling operations shall be performed by a qualified Contractor with at least ten years recent experience on similar projects using the excavation and tunneling lining methods that will be employed for this project. At all times, perform the work under the direction of an experienced project superintendent with at least five years recent on-the-job supervision experience on similar projects, involving tunnels of similar size constructed by similar methods. Demonstrate recent experience installing similar welded steel pipelines in tunnels.

C. Blasting consultants shall meet the requirements of Section 02229, Blasting.

D. Perform work in the presence of the Engineer, unless the Engineer has granted prior written approval to perform such work in his absence.

1.06 TOLERANCES

A. Variations from line shall not exceed three inches per 100 feet.

B. Variations from grade shall not exceed two inches per 100 feet.

1.07 SUBMITTALS

A. Written documentation of the qualifications of the tunnel Contractor, the project superintendent(s) and the blasting supervisor(s) when applicable for the type of tunnel construction employed. Provide three references for the Contractor and superintendent(s) on similar projects completed in the past five years. Submit a copy of the Blaster's License for each blasting supervisor when applicable for the type of tunnel construction employed or reference to previous submittal where included.

B. Description of the methods and procedures to be utilized in performing the work. Description shall include: tunnel excavation methods; types of initial support and presupport; proposed geometry and dimensions of the excavated tunnel; description of any proposed modifications or substitutions to the details shown on the Plans; procedures for hauling and disposal of tunnel muck; details to support face if soft-ground or mixed-face tunneling operations are interrupted; procedures for handling, control and disposal of surface water, tunnel water and groundwater; list of equipment to be used; equipment specifications; and other data requested by the Engineer.
C. Structural details for a full-circle tunnel shield including details of jacking propulsion system, breasting capabilities and methods for making line and grade corrections.

D. Plans of TBM showing, dimensions, method of operation, face control capability, cutterhead, disc cutter arrangement, propulsion system and alignment control system. Include descriptions of tunneling equipment features selected to be compatible with the expected rock mass conditions, including but not limited to: thrust per cutter; gripper system; finger shield; ability to install rock reinforcement; and circular steel rib initial support. Submit the manufacturer's machine details and working drawings, specifications, operating procedures, location of spare main bearing and other data pertinent to the performance of the TBM. Include drawings for dust control system, other ancillary equipment requested by the Engineer.

E. Survey methods and proposed procedures for alignment and grade control.

F. Details of tunnel lighting, ventilation, and electrical systems.

G. Description indicating the location(s) of material disposal site(s) and release(s) from property owner(s).

H. Plans for drilling and blasting operations and blast reports in accordance with Section 02229, Blasting.

I. Prepare a shift report of tunnel construction work for each work day and provide the Engineer with one copy on the following work day. The report shall include, but not be limited to, the following:

1. Location of tunnel face(s) by station at start and end of each work shift.
2. Tunnel excavation method(s) utilized.
3. Type, quantity, and location of initial support system.
4. Records of any observed deformation of the initial or temporary supports.
5. Survey records including the offset from design line and grade, and initial support measurements.
6. Description of excavated material, locations where material changes occur, material behavior and notes regarding occurrences such as unstable ground, groundwater inflows and estimated volumes, including the station or location and time of each occurrence.
7. Start and stop times and stations for each advance of a TBM or shield.
8. TBM clock time at the end of each shift, including identification of TBM downtime by category and duration. Categories of downtime include, but are not limited to, cutter changes; installation of initial support; groundwater inflow; power outages, electrical or mechanical repair; trailing gear difficulties; hydraulics repair; gripper reset problems; alignment survey; and routine maintenance.
9. Workforce, materials, equipment and duration of the different activities performed.

J. Applicable health and safety report requirements.

PART 2 - MATERIALS

2.01 TUNNEL SHIELD

A. Use a full-circle tunnel shield able to sustain any ground loads which may be imposed upon it as well as any loads imposed by thrust jacks and other appurtenances. The tunnel shield shall be capable of being controlled to the desired line and grade. Include the following specific characteristics and capabilities:

1. Provide tunnel shield with a uniform exterior surface from the leading edge to the trailing edge, free of projections that will produce overexcavation or voids. Projections for overcutters, if used, shall not
exceed 1/2-inch above the skin of the shield. Ensure that the shield is sufficiently strong to maintain its true shape during use.

2. The hood shall project beyond the shield bottom and the tail shall be long enough to provide support between the shield and the last installed element of the initial support when the shield has been pushed forward to the fullest extent possible. The length/diameter ratio shall not exceed 0.9.

3. Provide breast-jacks, breast tables, a closeable cutter wheel, or such other bracing as necessary to support the face of the tunnel excavation without loss of ground.

4. Provide a propulsion system capable of moving the shield in a forward direction, while maintaining the construction tolerances with respect to line, grade, and direction. The propulsion system shall include a thrust ring or other provision that will distribute the jacking forces uniformly around the tunnel perimeter so the shield can be advanced without damaging or distorting the initial support system. Backward movement and overstressing or distortion of the tunnel initial support shall not occur should any element of the propulsion system fail to operate.

5. Include provisions for the installation of an initial support system consisting of expanded steel ribs and steel lagging, in accordance with Section 02340, Tunnel Support Systems.

2.02 TUNNEL BORING MACHINE

A. Use a full-face, hard-rock TBM with the following specific characteristics and capabilities:

1. Configure the TBM to excavate to dimension limits shown on the Plans. The TBM shall be compatible with the anticipated geologic conditions and with any other methods of excavation to be used.

2. The TBM shall be able to cope with sustained groundwater inflows, and include considerations for efficient mucking.

3. Provide a full-face, cutterhead with narrow-opening muck-buckets and with complete breasting, especially heavy in the area of the gauge cutters, to effectively hold rock blocks in place until they are adequately broken by the cutters.

4. Provide serrations or "teeth" on the gripper shoes for gripping of hard, polished rock surfaces.

5. The TBM shall be capable of maintaining line and grade within the specified tolerances. TBM and trailing gear shall be capable of excavating a 1,000-foot radius curve.

6. Include provisions for installation of rock bolts.

7. Include provisions for installation of full perimeter initial supports, such as expanded circular steel ribs. The TBM and all trailing gear shall be able to advance through initial support without delay and without damaging initial support.

8. Provide a dust suppression system which, when combined with the ventilation system, is capable of meeting CALOSHA requirements.

9. Provide a power interruption system that will automatically shut down power to the TBM upon detection of noxious gases or fire.

10. Provisions shall be made to have readily available a spare main bearing that for the entire duration of the tunnel excavation can be shipped to the site within two weeks.
PART 3 - EXECUTION

3.01 GENERAL TUNNELING REQUIREMENTS

A. Tunnel excavation and initial support is classified according to three categories: rock tunneling, soft-ground tunneling and mixed-face transition zone tunneling. An estimate has been made of the location and length of tunnel in each category in the GDSR.

B. Prior to the start of tunnel excavation, conduct a safety conference in accordance with CALOSHA requirements. Arrange this conference and inform the Engineer at least seven days in advance.

C. Tunneling work shall be prosecuted in accordance with the approved working hours established for the project. Notify the Engineer at least 24 hours in advance of a change in working hours.

D. Perform tunneling operations in a manner that will minimize the movement of the ground in front of and surrounding the tunnel excavation. Take all necessary measures to minimize subsidence that can cause damage or disruption of the ground surface, road crossings and utilities above or in the vicinity of the tunnel, in accordance with Section 02305, Tunnel Instrumentation and Monitoring. Support the ground in a manner to prevent loss of ground and keep the perimeters and tunnel face stable.

E. Provide electrical, water, lighting, and other facilities required to complete the tunnel.

F. Maintain clean working conditions inside the tunnel. Immediately remove from the tunnel all muck, slush, grout spills and any other material not required for tunneling.

G. Enlargements of the tunnel opening for the Contractor's convenience may be performed when approved in writing by the Engineer prior to the start of excavation. Provide Shop Drawings describing completely the proposed works, including dimensions of the enlargement, excavation, support and concrete backfilling methods. Any enlargements shall be within the right of way shown on the Plans.

3.02 SAFETY

A. Perform tunneling operations by methods and with equipment which will positively control dust, fumes, vapors, gases, fibers, fogs, mists, and other atmospheric impurities.

B. Provide lighting and ventilation to ensure proper performance and inspection of work. Provide ventilation equipment and ductwork as close to the face as practicable.

C. Control noise and dust in accordance with applicable federal, state and local laws, safety codes, regulations and ordinances.

D. Equip muck trains with acceptable braking systems and safety chains to prevent runaway trains. Provide derailleurs or other safety equipment necessary to prevent trains from rolling out of the work area and for conducting safe muck transporting operations.

3.03 SOFT-GROUND TUNNEL EXCAVATION

A. Commence tunneling only after survey control points have been established, in accordance with Section 02305, Instrumentation and Monitoring.

B. On initial setup, support the tunnel shield on a cradle which will result in the correct line and grade.

C. Excavate materials in the heading using manual or mechanical excavation methods. Limit overexcavation beyond the shield outside diameter to less than one inch. Excavation shall be performed starting at the crown and proceeding down to the invert. The hood shall be kept buried in the soil ahead at all times.
D. During forward movement of the shield, provide sufficient support at the excavation face to prevent movement of materials, except such materials as are physically displaced by elements of the shield itself. Achieve control of the face using support procedures such as breasting, poling, face jacks, or other appropriate methods as necessary to maintain stability.

E. During shutdown periods or if the excavation work is interrupted for any other reason, the face shall remain supported. Shore shield tightly against the face. Breasting, bulkheading or any other element relying on support provided by hydraulic or collapsible rams or struts will not be accepted.

3.04 TBM EXCAVATION

A. Perform excavation only with the accepted TBM, in accordance with the approved Shop Drawings.

B. Install initial support as necessary in accordance with Section 02340, Tunnel Support Systems.

C. Prior to the installation of any support, scale down all loose rock. Perform periodic inspections for such purpose, and to relocate or repair any support that may have been affected.

D. Keep intake end of fan suction line as close to TBM as possible.

3.05 DRILL AND BLAST EXCAVATION

A. Carry out tunnel excavation to final rock surfaces involving blasting using smooth wall blasting techniques. Load perimeter holes with explosives manufactured specifically for perimeter control applications.

B. Meet the requirements of Fume Class 1 established by the Institute of Makers of Explosives for explosives for tunneling work.

C. Use horizontal holes in tunnel excavation. The round length shall be compatible with the actual ground conditions.

D. Immediately after each blast, inspect the roof and walls of the excavation by skilled scalers who shall dislodge and scale down all loose or shattered rock. Make periodic inspections of the blasted tunnel section and remove loose and unsafe rock. Check initial supports after each blast to tighten blocking and tighten or reset rock reinforcement which has loosened.

E. Use blasting mats as necessary to prevent flying rock during tunnel excavation near the portal(s).

F. Conform to Section 02229, Blasting, for blast design considerations, vibration limitations and suspension of blasting.

3.06 MIXED-FACE TUNNELING

A. Mixed-face tunneling will involve the use of hand-mining and/or drill and blast techniques in the same heading. Whenever practicable, excavate the soft-ground portion as an operation separate from drilling and blasting. Use presupport techniques such as crown bars, spilling, forepoling and breastboarding of the face, as necessary, to minimize loss of ground and to maintain the stability of the excavation. Drill and blast round lengths shall be suited to the prevailing ground conditions in order to minimize disturbance to the soft-ground portion of the heading.

B. Upon signs of instability during excavation, immediately suspend such activity, and proceed to stabilize the tunnel using ribs and lagging, shotcrete, rock reinforcement or combinations thereof as necessary. Continue excavation only after thoroughly supporting the unstable portions. If blasting is required, exercise special care to prevent damage to the support.
3.07 TUNNEL LINE, GRADE AND DEFORMATION

A. Control the excavation of the tunnel and construction of the initial support to allow construction of the pipeline in accordance with specified tolerances.

B. When excavation is off line and grade, return to plan line and grade at the rate of three inches per 100 feet.

C. Survey the crown, invert and springline of the initial support or rock surface at 25-foot intervals to ensure the alignment is within the tolerances specified. Conduct the survey immediately behind the tunnel excavation to allow immediate correction of misalignment.

D. Except as noted, the following requirements apply to the soft-ground portion of the tunnel excavated with a shield.

1. Take the following measurements within one hour after each rib is expanded against the ground:
   a. Measure the horizontal diameter of each rib at the springline to within plus or minus 0.01 foot.
   b. Measure the vertical height of each circular rib from the crown to the invert to within plus or minus 0.01 foot.

2. Take springline measurement specified above again approximately 24 hours after each rib is expanded and emerges from the tail of the shield.

3. Following these initial readings, the Engineer will select ribs for monitoring with convergence points, in accordance with Section 02305, Tunnel Instrumentation and Monitoring, including ribs to be installed in sections excavated with TBM, drill and blast or handmining techniques.

E. If in the opinion of the Engineer convergence measurements or other evidence indicate that excessive deformations are occurring, take corrective measures at once.

3.08 CONTROL OF WATER

A. Control water in the tunnel and take all means necessary for such control. Install and maintain temporary drainage facilities of adequate capacity, with standby pumps and emergency power for emergency use, to collect and dispose of water which enters the tunnel. Water will not be permitted to stand at the tunnel face or in working areas. Disposal of water shall be in accordance with Section 02140, Dewatering.

3.09 TUNNEL ACCESS

A. Provide the Engineer access to the tunnel for inspection and observation of the work, to perform line and grade surveys, to perform geologic mapping, and to monitor instrumentation. The Engineer will perform geologic mapping of the tunnel excavation as excavation proceeds. The Contractor shall cooperate with this effort as required.

B. The surveying, geologic mapping, instrumentation monitoring and other activities to be performed by the Engineer are not anticipated to obstruct construction activities for more than 30 minutes (average) per shift. All surveys, records and maps prepared by the Engineer will be made available to the Contractor.

3.10 MATERIAL DISPOSAL

A. Remove and dispose of excess excavated material in accordance with Section 02200, Earthwork. Unless approved in writing by the Engineer, do not dispose of excavated material within the pipeline right of way or temporary easements acquired for the project.

3.11 FINAL LINING

A. Install steel pipe in accordance with Section 02655, Installation of Pipe. Backfill and grouting shall be in accordance with Section 02330, Concrete Backfill and Grouting for Tunnels.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes requirements for portal and shaft development and includes all work required to prepare the areas for tunnel construction. This work includes, but is not limited to, access roads, staging areas, temporary disposal areas, portal and shaft excavation, temporary excavation support, fencing, signing, drainage seepage control, and site restoration following construction.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02140 Dewatering
B. Section 02200 Earthwork
C. Section 02229 Blasting
D. Section 02270 Temporary Erosion Control
E. Section 02305 Tunnel Instrumentation and Monitoring
F. Section 02310 Tunneling
G. Section 02340 Tunnel Support Systems
H. Section 02830 Fencing
I. Section 02940 Revegetation

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. California Administrative Code, Title 8, Division of Industrial Safety, Tunnel Safety Orders.

1.04 DEFINITIONS

A. Portal and Shaft Area Development: Excavation, grading and other construction activities necessary to provide access to the portal or shaft, and to prepare the respective areas for tunneling.
B. Temporary Support: Elements of the tunnel furnished and installed by the Contractor for support of temporary, open, cut, and portal area excavations.
D. Additional Definitions: See Section 02310, Tunneling.

1.05 QUALITY ASSURANCE

A. Comply with current applicable regulations and codes of federal, state and local agencies.
1.06 SUBMITTALS

A. Drawings and details for the proposed development at the portal or shaft. Show details indicating procedures for control and disposal of surface water runoff. Provide details indicating disposal site location(s) and stockpiling plans for excavated materials, if stored on-site, and release(s) from property owner(s), if stored off-site.

B. Drawings and details indicating provisions for temporary support of excavated cut slopes. Provide details of slope stabilization including installation methods, construction sequence and procedures, design loading conditions, slope stabilization elements, soil and rock properties, and any other assumptions incorporated in the drawings and details.

C. Copy of proposed portal area development shift report and blast report forms.

D. Prepare a shift report of portal construction work, and provide the Engineer with one copy of the shift report on the following work-day. Shift reports shall include the following:

1. Location and description of portal or shaft area development work completed.
2. Type, quantity, and location of temporary support installed.
3. Workforce, materials and equipment involved, and duration of the activities performed.
4. Records of any observed deformation of the temporary supports.
5. Notes regarding occurrences such as unstable ground, groundwater, work delays and equipment malfunction, including the location and time of each occurrence.

PART 2 - MATERIALS - NOT USED

PART 3 - EXECUTION

3.01 GENERAL

A. The portals may be developed as an open cut excavation, supported shaft excavation, or combination of both, at the Contractor's option. Construction easement limits for the portals are shown on the Plans. Ensure that actual portal and shaft development and temporary access road construction are compatible with selected construction methods, procedures and equipment. Develop the portals in accordance with specified requirements and the accepted Shop Drawings. Any proposed modifications shall not encroach or disturb the ground surface outside the construction easement limits shown on the Plans.

B. Install excavation support systems in accordance with accepted Shop Drawings. If movements indicate that support system requires modification to prevent further movements, and resubmit modified drawings and details to the Engineer. Remove all temporary support prior to completion of the work except as permitted by the Engineer.

3.02 TEMPORARY SLOPES

A. Excavate and stabilize temporary slopes employing methods shown on the Shop Drawings. Temporary slope design shall consider stability against shallow raveling, block sliding, and deep seated rotational failure, and degradation or deterioration of slope materials exposed to the environment. Temporary slopes in earth shall not be steeper than one horizontal to one vertical without support measures such as shoring and slope reinforcement, although surface treatment to prevent erosion of excavated slopes may be required. Temporary slopes in rock may be steeper, and stabilized with shoring, rock reinforcement, surface treatment or combinations thereof, as necessary. Surface treatment methods may include shotcrete, chain-link fabric or wire mesh anchored to slope faces to prevent slope raveling or deterioration.
3.03 BLASTING
A. Conform to Section 02229, Blasting.

3.04 TEMPORARY DRAINAGE
A. Install and maintain temporary drainage facilities of adequate size, standby pumps and adequate power for emergency use, to collect and dispose of water which enters the portal, shaft or tunnel excavations. Do not allow water to stand in working areas. Dispose of water in accordance with Section 02140, Dewatering.

3.05 MATERIAL DISPOSAL
A. Remove all surplus excavated materials from the work site and dispose of or stockpile on-site in accordance with the requirements of Section 02310, Tunneling.

3.06 FENCING AND SIGNS
A. Construct fencing entirely around the portal and shaft areas to prohibit public access to the work site as indicated on the Plans. Construct fencing in accordance with Section 02830, Fencing. Modifications to the fencing requirements are subject to the approval of the Engineer. Provide locked gates at access roads. Provide adequate lighting and place signs warning the public that construction activities, including blasting operations, are in progress.

3.07 RESTORATION
A. Restore to original condition any ground surface features, utilities or any other structures which are damaged, moved or disturbed as a result of the portal or shaft construction. Restore portal and shaft areas to original pre-construction topographic conditions except as indicated on the Plans. Grading for site restoration shall be completed in accordance with Section 02200, Earthwork.

B. Remove trailers, temporary utilities, drainage facilities and other site development facilities from the site following the completion of backfilling. Remove all shoring from the excavation unless permitted otherwise by the Engineer. Remove the support system from the site in a manner that will neither disturb nor harm adjacent construction or facilities. Immediately fill all voids created by the removal of the support system with sand, or sand-cement grout. Remove fencing except for fencing to be relocated and fencing to be left in place as shown on the Plans. Revegetation of disturbed areas shall be carried out in accordance with Section 02940, Revegetation.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section covers material and equipment for concrete backfill and low pressure grouting (20 psi or less) in the annular space between the final tunnel lining and the primary support system in the tunnel.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02310  Tunneling

B. Section 03000  General Concrete Construction

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Society for Testing and Materials

   A53  Specification for Pipe, Steel Black and Hot-Dipped Zinc Coated, Welded and Seamless.

   C39  Test Method for Compressive Strength of Cylindrical Concrete Specimens.

   C144  Specification for Aggregate for Masonry Mortar.

   C150  Specification for Portland Cement.

   C495  Test Method for Compressive Strength of Lightweight Insulating Concrete.

   C796  Test Method for Foaming Agents for Use in Producing Cellular Concrete Using Preformed Foam.

   C869  Specification for Foaming Agents Used in Making Preformed Foam for Cellular Concrete.

B. State of California, Department of Transportation, Manual of Test Volume 1-2-3 (Standard Test Methods)

   Test 417 - Method of Testing Soils and Waters for Sulfate Content

   Test 422 - Method of Testing Soils and Waters for Chloride Content

1.04 QUALITY ASSURANCE

A. Demonstrate experience on at least three projects using similar concrete backfill, grouting materials, and procedures.

B. Test low-density cellular concrete in accordance with ASTM C495 and C796. Determine the wet and dry density of cellular concrete mixes in accordance with ASTM C796. Test concrete backfill in accordance with ASTM C39.

C. Prepare trial mixes of the proposed cellular concrete backfill. Prepare two sets of compression test cylinders, three cylinders per set, from each trial mix. Test one set of cylinders at an age of seven days and the other set of cylinders at an age of 28 days.

D. Field Tests

   1. Measure cellular concrete weights at point of placement in the tunnel to determine its cast density. Weights measured at the beginning of the day will be used to adjust the mix accordingly to achieve
the proper cast density. Approximately each hour thereafter, weights shall be measured to check and ensure correct density.

2. One set of four cellular concrete test cylinders (3” x 6”) will be made for each 100 cubic yards of material placed until seven-day breaks are returned. With acceptable seven-day breaks, the collection of concrete test cylinders may be decreased at the discretion of the Engineer. Concrete cylinder testing will be provided by Engineer.

3. Provide a system of valves or other means at both the point of discharge and at the point of placement to allow sampling and density checks.

1.05 SUBMITTALS

A. Description of experience demonstrating required qualifications for concrete backfilling and grouting pipes and tunnels. Submit project name and details, contact, and phone number for three projects.

B. Drawings showing the method of preventing pipe flotation and how the concrete backfill will be terminated at the ends of the tunnel.

C. Proposed concrete backfill mix design, and the procedures, methods, and equipment for placing concrete backfill around pipe.

D. Trial mix details and testing results for cellular concrete backfill trial mixes.

E. Certification from the pipe supplier that proposed blocking details to prevent flotation, and backfilling procedures are in accordance with their recommendations and will not damage pipe. Provide calculations demonstrating that pipe will not deflect or otherwise be damaged during backfilling operations.

F. Modifications to mix design or backfilling procedures.

G. Details of equipment, grout mixes, grouting procedures, and sequencing.

H. Maintain and submit daily logs of grouting operations, including pressures, volumes, and grout mixes.

PART 2 - MATERIALS

2.01 CONCRETE BACKFILL

A. Use Type II, low alkali, cement conforming to ASTM C150.

B. Water shall be free of organic materials and other impurities, which might reduce the strength, durability or other quality of the cement mortar. Water shall have a pH of 7.0 to 9.0, a maximum chloride concentration of 500 mg/l (per Caltrans test method 422), and a maximum sulfate concentration of 500 mg/l (per Caltrans test method 417).

C. Meet the requirements of ASTM C869 for foaming agents. Foaming agents shall be Mearl Geofoam Liquid Concentrate supplied by the Mearl Corp., Roselle Park, New Jersey, or equal.

D. The minimum seven day and 28 day compressive strength of concrete backfill and cellular concrete backfill shall be 300 psi and 500 psi, respectively. Cellular concrete wet density shall be not less than 45 pcf at the point of placement.

E. Conform to the requirements of Section 3000, General Concrete Construction, for admixtures. Admixture content, batching method, and time of introduction to the mix shall be in accordance with the manufacturer’s recommendations for minimum shrinkage and for compliance with these specifications. Admixture use shall be in accordance with the manufacturer's recommendations.
F. The foaming agent supplier shall review the project requirements and approve, in writing, the materials, equipment, procedures, trial mix and final mix to be used. A field representative of the supplier shall be onsite during initial backfilling operations to observe the work and recommend any necessary modifications. Mix design changes shall be reviewed by the foaming agent supplier and written comments submitted to the Engineer for approval prior to use.

2.02 GROUT

A. Cement shall conform to Section 03000, General Concrete Construction.

B. Sand shall conform to ASTM C144 with a fineness modulus between 1.5 and 2.0, and the following gradation:

<table>
<thead>
<tr>
<th>Sieve Sizes</th>
<th>Percentage Passing By Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 8</td>
<td>100</td>
</tr>
<tr>
<td>No. 16</td>
<td>95 - 100</td>
</tr>
<tr>
<td>No. 30</td>
<td>60 - 85</td>
</tr>
<tr>
<td>No. 50</td>
<td>20 - 50</td>
</tr>
<tr>
<td>No. 100</td>
<td>10 - 30</td>
</tr>
<tr>
<td>No. 200</td>
<td>0 - 5</td>
</tr>
</tbody>
</table>

C. Fluidifier shall be Interplast-N manufactured by Sika Chemical Corporation, Lynhurst, New Jersey, or equal. The fluidifier shall contain a shrinkage compensator, and shall not contain bentonite or other clay-like substances.

D. Admixtures may be used subject to the acceptance of the Engineer to improve pumpability, control time of set, to hold sand in suspension, and to provide segregation and bleeding. Use admixtures in accordance with manufacturer's recommendations. Do not use admixtures that promote steel corrosion.

2.03 GROUT COUPLINGS AND PLUGS

A. Piping for grout shall be two-inch diameter black steel pipe, standard weight (schedule 40), conforming to the requirements of ASTM A53. Couplings shall be malleable iron. Plugs to be installed in the couplings shall be steel.

PART 3 - EXECUTION

3.01 PLACING CONCRETE BACKFILL

A. Following pipe installation, completely fill the annular space between the pipe and the tunnel walls and/or initial supports with concrete backfill or cellular concrete backfill in accordance with the following:

1. Use vertical construction joints at bulkheads.

2. Use pumping equipment for placing concrete backfill in the annular space.

3. The limits of each concrete placement operation shall be acceptable to the Engineer.

4. Produce cellular concrete by combining controlled quantities of air, water, and foaming agents under pressure. Foam shall retain its stability until the cement sets to form a self-supporting matrix. The resulting cellular concrete shall have essentially closed cell and low water absorptive characteristics. The concentration of foam agent shall be in accordance with the foaming agent material manufacturer's recommendations. Warm water used in preforming the foam shall not exceed 80 degrees F.
5. At the start of the concrete backfilling operations, extend the concrete discharge pipeline from the placing equipment to the point of lowest elevation of the section of pipe being backfilled. The methods used in placing the concrete shall be such as to ensure the complete filling of the annular space between the bulkheads. Concrete backfill shall be of proper consistency and shall be adequately consolidated to fill all voids.

6. Place concrete backfill in at least two lifts to prevent pipe flotation unless stiffeners or pipe supports and closely-spaced blocking of sufficient structural rigidity are provided to prevent pipe flotation, movement, and damage to the pipe. Lift thickness required to prevent flotation and damage to the pipe will be determined by the Contractor.

3.02 GROUNDWATER CONTROL
   A. Control water in the tunnel as specified in Section 02310, Tunneling, for tunnel construction. Operate drainage system installed for tunnel until cellular concrete backfill placement is completed.

3.03 GROUTING
   A. Fill any voids between the final lining and concrete backfill, between the concrete backfill and initial support, and behind initial support with grout. Place grout through grout couplings provided in the final lining as shown on the Plans or as accepted by the Engineer. Do not perform grouting until the concrete backfill has achieved sufficient strength to withstand the maximum grout pressure, but in no case shall this be less than 72 hours after placement of concrete backfill.

   B. Use equipment of adequate size to satisfactorily mix and agitate the grout and force it into the grout holes, in a continuous flow at the specified pressure. Use pumps capable of continuously developing a uniform pressure of 15 pounds psi at the grout hole connection.

   C. Provide an arrangement of grouting equipment for continuous circulation of grout in the system and accurate pressure control. Keep equipment and hoses clean by constant circulation of grout and by periodic flushing with water.

   D. Provide a mixer with a meter for measuring the amount of mixing water used, calibrated to read in cubic feet to the nearest one-tenth of a cubic foot.

   E. Provide mechanical agitator tanks equipped with suitable screens in addition to the grout mixer.

   F. Provide two pressure gauges, one at the grout pump and one at the manifold hookup at the collar of each hole being grouted. Periodically check the accuracy of the gauges with an accurately calibrated high pressure gauge.

   G. Provide equipment and conduct grouting procedures such that grouting pressures will not exceed the maximum specified at the grout hole connection. Provide suitable stop valves at the collar of each hole for use in maintaining pressure as required until the grout has set.

   H. Provide grouting equipment with a meter to determine the volume of grout injected, calibrated to the nearest one-tenth of a cubic foot.

   I. Maintain grouting equipment in satisfactory operating condition to ensure continuous and efficient grouting operations.

   J. Use hoses for grouting operations having an inside diameter not less that 1-1/2 inches, and capable of withstanding the maximum water and grout pressures to be used.

   K. Drill grout holes through the cellular backfill with rotary or percussion type drilling equipment.
3.04 GROUT COMPOSITION

A. Provide cement grout consisting of Portland Cement, fluidifier, and water in the proportions specified herein or as accepted by the Engineer. Sand may be added to the grout mix in instances of very high grout takes as accepted by the Engineer, but in no case shall the grout mix contain more than three parts sand to one part cement by weight. Anticipate that the addition of sand will require additional fluidifier to be added to the grout mix. Express grout mix (water/cement) ratios in cubic feet of water per cubic feet of cement (94 lb bag). Vary the water-cement ratio by volume to meet the characteristics of the holes as they develop during the grouting operation. The range of water-cement ratios shall be between 2:1 and 0.75:1 by volume. The use of 2:1 mixes will be allowed only in attempts to grout holes which show a very low rate of grout take. The grout shall contain a fluidifier, in the proportion of one percent by weight of cementitious material or as recommended by the manufacturer.

B. Recirculate all grout mixes in the grout lines when any initial or new mix is batched or after adding water, fluidifier, or sand to the mix. Recirculate the mix for at least two minutes after return prior to pumping the grout in the grout hole.

3.05 MIXING AND INJECTION OF GROUT

A. Provide materials free of lumps when put into the mixer and agitate the grout mix constantly. Grout shall flow unimpeded and shall completely fill all voids. Waste grout not injected after 90 minutes of mixing.

B. Drill 1-1/2 inch minimum diameter grout holes through the cellular concrete backfill and any initial support and at least two inches into rock or undisturbed soil. Drill grout holes through nipples threaded onto each grout coupling to avoid damaging the threads of the grout couplings. Redrill grout holes used for return prior to grouting.

C. The locations of grout holes are shown on the Plans. Drilling grout holes through pipe, except through attached grout pipes and couplings, will not be permitted.

D. Make connections for injecting grout at each hole drilled for each pipe coupling. Inject grout continuously, filling all spaces and voids and avoiding disturbance of grout which has taken initial set. Operate and control the grouting process so that the grout will be delivered uniformly and steadily.

E. Perform grouting from grout coupling to grout coupling pipe in the sequence indicated in the Shop Drawings.

F. In general, grouting will be considered completed when less than one cubic foot of grout can be pumped in 15 minutes under the specified maximum pressure. After the grouting at any grout pipe is finished, maintain the pressure by means of a stopcock or other suitable device until the grout has set. Fill any voids left after removing the packer or grout pipe with mortar. Provide mortar of a stiff consistency mixed in the proportions of one part cement to two parts sand. Replace grout plugs in pipe at the completion of grouting. Fill depressions or recesses in the mortar lining at the couplings with mortar.

G. Use a minimum grouting pressure of at least 10 pounds psi at the grout hole collar connection, unless otherwise directed by the Engineer.

H. Do not exceed the maximum grouting pressure 15 pounds psi at the grout hole collar connection.

I. Grouting operations are to be performed in the presence of the Engineer. Notify the Engineer at least 24 hours in advance of the startup of a grouting operation.

J. Attach grout couplings to the pipe at the fabricating plant as shown on the Plans.

K. Drill grout holes following within 100 feet of the cellular concrete backfill placement so as to test the degree of completeness of the backfilling. If incomplete backfilling is revealed by the drilling operations, modify backfill placement procedures to ensure that all voids are completely filled.
3.06 CLEANUP

A. Take necessary precautions to protect and preserve the interior mortar lining of the pipe from damage. Any damage to the lining caused by or occurring during the grouting operations shall be repaired. The interior lining of the pipe shall be maintained smooth and free from defects.

B. During grouting and concrete backfill work, provide for adequate disposal of waste and wastewater. Minimize grout and concrete spills and cleanup immediately after grouting and backfilling. Remove waste grout and cellular concrete caused by grouting and backfilling operations.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes requirements for tunnel initial support systems. Initial support for the soft-ground portion of the tunnel excavated with a shield shall conform to the requirements included herein. Design of initial support for other portions of the tunnel is the responsibility of the Contractor.

B. Anticipated geologic conditions are described in the GDSR for the project. The GDSR is provided for information only and is not part of the Contract Documents.

C. Initial supports shall be sized for appropriate loading conditions, including but not limited to: handling and installation stresses; loads imposed by subsequent construction operations; rock, soil and water loads; ground subsidence and convergence control; grouting; and other conditions of service.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02310 Tunneling

B. Section 02315 Portal Area Development

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Concrete Institute
   506.2-77 Specification for Materials, Proportioning and Application of Shotcrete.

B. American Society for Testing and Materials
   A36 Specification for Structural Steel.
   A185 Specification for Steel Welded Wire Fabric, Plain for Concrete Reinforcement.
   A325 Specification for High Strength Bolts for Structural Steel Joints.
   A563 Specification for Carbon and Alloy Steel Nuts.
   A615 Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   F436 Specification for Hardened Steel Washers.

1.04 SUBMITTALS

A. Structural drawings and details for each initial support system proposed including assumed ground loading conditions and anticipated rock mass or ground behavior. Refer to the GDSR for discussion of anticipated ground and rock mass conditions, ground and rock loads, and expected ground behavior. Indicate areas where the planned initial support systems will be installed.

B. Provide the following for the support system specified for the soft-ground portion of the tunnel excavated with a shield:
   1. Structural calculations indicating that the proposed initial supports can withstand shield jacking loads.
2. Calculations for connections. Connections for tunnel initial supports shall be sized to transfer the full structural capacity to the member.

C. Fabrication and assembly drawings indicating the details of the proposed steel rib supports. Include the following information and any other additional details as requested by the Engineer.

1. Sizes and shapes.
2. Details, arrangements and spacing of members, including tie rods and/or collar braces.
4. Lists of materials.
5. Method(s) and details of blocking.
7. Foot block details for nonexpanded steel ribs and proposed materials.

D. Provide the following information for rock reinforcement:

1. Proposed layout and installation procedures for rock reinforcement.
2. Proposed drilling equipment and drill hole size.
3. Type, size, length, and spacing of rock reinforcement.
4. Applicable literature of both steel bar and resin manufacturers, including manufacturers’ recommended installation procedures.
5. If resin grout will be used, provide manufacturer's certified test results of gel time and working strength for each type of resin grout to be used. Provide test results demonstrating compliance with the strength requirements contained herein. Provide samples of resin cartridges for each setting period to be used.
6. Surface treatment measures such as chain link fabric or wire mesh. Provide details of surface treatment measures such as size, capacity, material specifications and installation procedures.

E. Provide the following and any other information necessary to verify shotcrete compliance with ACI 506.2-77:

1. Shotcrete mix design.
2. Shotcrete strength requirements.
3. Shotcrete equipment and application procedures.
4. Shotcrete testing requirements and quality control procedures.

1.05 TOLERANCES

A. Steel Rib Fabrication

1. Chord, measured on centerline of rib: Theoretical length plus or minus 1/16 inch.
2. Face of butt or foot plates: Within plus or minus 1/16 inch of theoretical plane.
3. Gap between ends of ribs and butt or foot plates prior to welding not exceeding 1/16 inch for at least 75 percent of the cross sectional area of the rib. Where gaps are in excess of 1/16 inch, fill by additional welding.

4. Tie rod holes in rib webs: Within plus or minus 3/8 inch of the locations shown on the approved Shop Drawings.

5. Width or length of sheared plates: Within the theoretical dimensions plus or minus 1/8 inch.

6. Center to center of bolt hole dimensions on butt or splice plates: Theoretical dimension plus or minus 1/16 inch.

7. Bolt hole groups in butt or splice plates after fabrication: Within plus or minus 1/16 inch of the theoretical location regardless of the variations in the rib resulting from other tolerances.

B. Steel Rib Bending

1. Conformance to true template
   a. Plus or minus 3/8 inch between end plates and plus or minus 1/8 inch in three foot gauge depth.

2. Bending curvature: Uniform.

3. After bending:
   a. Outer flange will be permitted to deflect 1/8-inch maximum toward the inner flange for radii of bend less than 14 times the rib depth.
   b. Buckling of the web for a distance of half the rib depth from either end will be permitted with deviation from the flat no greater than plus or minus 1/8 inch for radii of bend equal to 14 times the rib depth or greater.
   c. Buckling of the web for a distance equal to the depth of the rib from either end will be permitted with deviation from the flat no greater than plus or minus 3/16 inch for radii of bend less than 14 times the rib depth.
   d. Rib depth at the web: Not less than the theoretical depth minus 1/4 inch.

PART 2 – MATERIALS

2.01 GENERAL

A. Initial support may consist of rock reinforcement, shotcrete, steel support members, lagging and blocking, spilling, channels, straps, forepoling, crown bars, wire mesh or combinations thereof. The use of timber is limited to certain portions of the tunnel.

2.02 STEEL SUPPORTS

A. Provide steel supports and auxiliary structural members free of rust and defects which may impair or reduce their structural integrity. Provide ribs accurately bent to approved horseshoe shape for the proper radius of tunnel section. Rib segments shall fit closely for bolted joint connections. Provide steel appurtenances required for the installation of the ribs such as tie rods, collar braces, bolts, splice plates, drift pins, etc., with the ribs. Use structural steel conforming to ASTM A36 for ribs, posts, beams, channels, plates, rods, and bars. Foot blocks shall be timber, steel, precast concrete, or sacked concrete. Bolts shall conform to ASTM A325.

2.03 STEEL LAGGING AND CHANNEL SUPPORTS

A. Use structural steel conforming to ASTM A36 for steel lagging and steel channel supports.
2.04 TIMBER

A. Timber for block, lagging, foot blocks, cribbing or other parts of initial support shall be sound, well seasoned lumber of construction grade or better and of rectangular cross section.

2.05 ROCK REINFORCEMENT

A. Rock reinforcement may be tensioned or untensioned, and may include grouted installations, friction rock stabilizers, or mechanical rock bolts. Rock reinforcement also includes the use of surface treatment measures such as wire mesh, chain link fabric or mine straps, to prevent fallout in between reinforcement elements, where required.

B. Resin-grouted deformed reinforcing bars shall meet the following requirements:

1. Reinforcing bars shall be standard deformed reinforcing steel bars or continuous threadbars conforming to the requirements of ASTM A615, Grade 60.

2. Bar sizes shall be 7/8 inches (No. 7 rebar) or larger.

3. Bars shall be a single length of deformed steel except where construction sequence limitations require the use of shorter lengths suitably connected with coupling. Minimum length shall be five feet.

4. Provide bars that are continuously threaded or have at least six inches of rolled thread on the outer end.

5. Rock reinforcement assembly shall include bar, bearing plate, washers and nut. Provide hardened steel washers, flat or bevelled, as required, conforming to ASTM F436. Provide heavy-duty steel hex nuts conforming to ASTM A563.

6. Resin grout used for rock reinforcement shall be the product of an established manufacturer who has been regularly engaged in production of these products for at least five years. Provide resin grout having the following properties:

<table>
<thead>
<tr>
<th>Properties</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultimate Compressive Strength</td>
<td>14,000 psi</td>
</tr>
<tr>
<td>Ultimate Tensile Strength</td>
<td>2,500 psi</td>
</tr>
<tr>
<td>Ultimate Shear Strength</td>
<td>4,800 psi</td>
</tr>
</tbody>
</table>

7. Provide resin in cartridge form. Cartridges shall have castings constructed of saturated polyester resin providing optimum resistance to moisture, but fragile enough to enable complete mixing during installation. The materials shall have thixotropic and viscous properties to permit adequate mixing of the materials by rotation of the bar and to prevent the mixture from running out of the hole or joints after mixing.

8. Provide polyester resin cartridges that are readily and individually identifiable as to their respective gel times. Provide cartridges with gel times as recommended by the manufacturer for each specific length and type of rock reinforcement. The cartridge packages shall be labeled with the expiration date. Do not use materials exceeding the manufacturer's expiration date. Store resin in accordance with the manufacturer's recommendations.

B. Friction rock stabilizers or mechanical rock bolts shall meet the following requirements:


2. Minimum length shall be five feet.
3. Roof plate size shall be as recommended by the manufacturer.

2.06 SHOTCRETE

A. Provide shotcrete conforming to the requirements of ACI 506.2-77. Shotcrete compressive strength shall be not less than 4,000 psi in 28 days.

2.07 WELDED WIRE FABRIC

A. Provide welded wire fabric in accordance with ASTM A185.

PART 3 - EXECUTION

3.01 GENERAL

A. Install initial support as soon as possible after exposing the soft ground or rock excavation and as close to the heading as the work will permit. Before installing initial supports, remove any loose rock. Any damaged or displaced initial support, and any improperly installed initial support shall be removed and replaced or repaired immediately in a manner acceptable to the Engineer. Elements of the initial support system shall be maintained in good condition until pipeline construction is complete.

B. The Contractor shall be responsible for developing procedures to support the ground surface above and around the tunnel in a safe manner, for maintaining stability of the ground adjacent structures, utilities and other improvements, for safety during excavation and support installation. This may locally mandate presupport installation during excavation.

3.02 EXPANDED CIRCULAR STEEL RIBS AND LAGGINGS

A. Install expanded circular steel ribs and full-perimeter steel lagging as initial support for the soft ground portion of tunnel excavated with a shield.

B. Install expanded circular steel ribs and steel lagging as necessary in the portion of tunnel excavated with a TBM, if steel ribs are used for initial support.

C. Erect steel ribs and lagging within the tail of the shield and upon emerging from the tail immediately expand the ribs to achieve continuous contact with the surrounding ground.

D. Expand the ribs by jacking at two locations across the joints between adjoining rib segments. Upon completion of expansion, fill the joints with steel spacers (dutchmen), steel wedges or plates, and bolt or pin each joint in a manner that will not allow relaxation or inward movement of the ribs.

E. Secure ribs against longitudinal movement or distortion by the use of steel tie rods or braces. Maximum circumferential tie rod or brace spacing shall be four feet along rib centerline.

F. Fit full-perimeter steel lagging between ribs so that no opening large enough to permit inflow of soil exists. Install plywood backing at the point(s) of separation between lagging that occur as the result of rib expansion, in such a manner as to provide continuous support at the outside circumference of the support system.

G. Fill voids behind the ribs and lagging with pea gravel, grout or other material of such consistency to prevent loosening of the ground or movement of the ground through the lagging.

3.03 NONEXPANDED STEEL RIBS AND LAGGING

A. Nonexpanded steel ribs may not be used in the portions of tunnel excavated with the shield or the TBM.

B. Install steel ribs to required line and grade, block, braced and wedged securely against rock surface. Check blocking and retighten after every blast or more frequently if necessary to support the rock securely.
C. Install ribs as soon as possible after exposing ground by excavation and as close to heading as work will permit.

D. Secure steel ribs against longitudinal movement or distortion by steel tie rods or members and compression struts. Supports that settle or move inside the A-line shall be reset.

E. Provide and install foot blocks of sufficient size to prevent rib settlement under load. Place foot blocks on a firm foundation at the base of the sidewalls. Prior to placing foot blocks, clear the base of the sidewalls of all loose material.

F. Provide lagging as necessary to maintain the safety of the excavation. Prior to installation of the pipeline, remove or arrange lagging to the extent possible to permit ready flow of cellular concrete backfill through and around the lagging and blocking so the cellular concrete backfill will be in contact with at least one-half of the excavated surface area bounded by the centerline of adjacent steel supports and any two longitudinal lines five feet apart. Lagging or blocking are not to be used for the purpose of reducing the amount of concrete between the rock surface and the pipeline.

G. Where ground conditions are encountered that require more than 50 percent lagging to achieve necessary surface support and protection, use a method other than timber lagging. Acceptable alternatives include shotcrete, steel lagging, steel liner plate, expanded metal grillage, or other comparable method. Fill voids between such steel lagging or liner plate and the surrounding ground with pea gravel, grout or other material of such consistency to prevent movement behind lagging.

H. Repair or replace ribs and lagging installed improperly or damaged during construction.

### 3.04 ROCK REINFORCEMENT

A. Where rock reinforcement is used, install rock reinforcement as close to the heading as possible.

B. If the rock reinforcement fails to provide satisfactory stabilization of the tunnel excavation as determined by the Engineer, modify or change to another type of rock reinforcement or initial support.

C. Install rock reinforcement in accordance with the approved Shop Drawings.

D. Provide rock reinforcement that is adequate at all times to ensure safety of personnel and construction operations.

E. Check nuts and split set roof plates periodically, and retighten or reset as required for support of the ground.

F. Furnish and install wire mesh or mine straps in conjunction with rock reinforcement installation as necessary.

### 3.05 SHOTCRETE

A. Prior to application of shotcrete, clean the exposed rock surface of loose material, dirt, dust, mud and other foreign matter. Shotcrete application shall conform to the requirements of ACI 506.2-77. Provide all shotcrete testing and quality control to ensure adequate shotcrete quality. Shotcrete thickness applied shall not hinder pipe installation or cellular concrete backfilling operations.

### 3.06 ADDITIONAL SUPPORT

A. Install additional support not shown on the approved Shop Drawings as necessary to stabilize the tunnel excavation. The type of initial support installed as additional support is the Contractor's option but shall conform to the requirements stated herein and the clearances shown on the Plans.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes grading, preparation of subgrade, furnishing and installation of base materials, and installation of wearing surface for permanent access road construction. Access roads will be constructed at the locations shown on the Plans and as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02110 Clearing and Grubbing
B. Section 02200 Earthwork
C. Section 02270 Temporary Erosion Control
D. Section 03000 General Concrete Construction

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Society for Testing and Materials
   A185 Steel Welded Wire Fabric, Plain for Concrete Reinforcement.
   D75 Practice for Sampling Aggregates.
B. State of California Department of Transportation Standard Specification.
D. Regional Standard Drawings for San Diego Area.

1.04 SUBMITTALS

A. Report from a testing laboratory a minimum of 28 days prior to the use verifying that material is asbestos free and conforms to the specified gradations or characteristics for gravel and crushed rock.
B. Concrete mix design.
C. Delivery ticket for each load of asphalt concrete.

PART 2 - MATERIALS

2.01 NATIVE MATERIAL

A. Native materials shall conform to Section 02200, Earthwork, with maximum size of rock particles no greater than two inches.
2.02 AGGREGATE BASE
   A. Aggregate for base or road course shall be Class 2 Aggregate Base in accordance with Section 26 of CALTRANS Standard Specifications, except that the minimum sand equivalent shall be 30. Aggregate grading shall be 1-1/2 inch maximum.

2.03 ASPHALT CONCRETE
   A. Asphalt concrete pavement shall comply with C1-AR-4000 asphalt concrete in accordance with Section 203 of the SSPWC.
   B. Asphalt concrete dikes shall comply SDARSD G-5, Type A.

2.04 TACK COAT
   A. Tack coat shall be either AR-1000 paving asphalt or Grade SS-1h emulsified asphalt and shall conform to Section 302-5.4 of the SSPWC.

2.05 CONCRETE PAVEMENT
   A. Concrete shall conform with Section 03000, General Concrete Construction. Concrete shall be Class B.

2.06 WELDED WIRE FABRIC
   A. Welded wire fabric shall conform to ASTM A185 for plain fabric. Welded wire fabric shall be 6x6-W5xW5.

PART 3 - EXECUTION

3.01 ACCESS ROAD CONSTRUCTION
   A. Clear and grub the full width of the access road per Section 02110, Clearing and Grubbing.
   B. Construct cuts or fills required to establish the road grade in accordance with Section 02200, Earthwork.
   C. Construct access roads per typical section shown on the Plans. Construct access roads to existing and new structures. Locate access roads within 15 feet of the pipeline centerline, or as shown on the Plans. Minimum inside curve radius shall be 50 feet. Road alignment shall branch off to provide access to pipeline appurtenance structures.
   D. Maintain access to all existing facilities.

3.02 SUBGRADE PREPARATION
   A. Complete all backfilling, compaction and grading prior to scarifying, compacting, and installation of road base or paving.
   B. The full width of the access road shall be scarified to a minimum depth of six inches and recompacted to a minimum density of not less than 90 percent of the maximum dry density in accordance with ASTM D1557 at plus or minus two percent of optimum soil moisture content.
   C. Where unsuitable subgrade material is encountered replace with compacted native material or crushed aggregate base placed in six-inch to eight-inch lifts and compacted to not less than 95 percent of maximum dry density in accordance with ASTM D1577 at plus or minus two percent optimum soil moisture content.
   D. Do not vary subgrade more than .05 feet in 10 feet from a uniform grade along the centerline of the road and perpendicular to the centerline.
3.03 SOIL STERILIZATION

A. Apply soil sterilant to the subgrade at a uniform rate of eight ounces per square yard, subject to the manufacturers recommendation, the entire width of the access road. Sterilant applied in dry form shall be lightly sprayed with water to prevent loss. Soil sterilant shall be as manufactured by U.S. Borax, Tompson-Hayward Chemical Company, or equal.

3.04 SPREADING AND COMPACTION OF AGGREGATE BASE

A. Control the movement, stockpiling and placement of aggregate base to prevent contamination or segregation. Contaminated or segregated aggregate may be rejected by the Engineer.

B. Place aggregate base in layers of uniform thickness by a suitable method to avoid segregation and compact to not less than 95 percent of the maximum dry density in accordance with ASTM D1557 at plus or minus two percent of optimum moisture content.

C. Form and compact the edges of the aggregate to provide side support where asphaltic concrete pavement is to be placed. The base shall be trimmed to the full width of the asphaltic pavement.

3.05 ASPHALTIC CONCRETE PAVEMENT

A. If the asphalt concrete pavement is being constructed directly upon an existing hard-surface pavement, apply a tack coat conforming to the requirements of Section 302-5.4 of the SSPWC.

B. Construct asphaltic concrete pavement at the locations and thicknesses shown on the Plans. Conform to the requirements of Section 302-5.5 of the SSPWC, except the surface variation shall not exceed 0.05 feet in 10 feet from a uniform grade, both along the centerline and perpendicular to the centerline.

C. Compact asphaltic concrete paving with an eight ton minimum steel wheeled roller. Pneumatic tired rollers will not be permitted to compact asphaltic concrete paving.

3.06 INSTALLATION OF CONCRETE PAVEMENT

A. Construct concrete pavement at the locations and thickness shown on the Plans in conformance with Section 03000, General Concrete Construction. Finish concrete pavement to conform to finish designation U-5.

3.07 INSTALLATION OF ASPHALT CONCRETE DIKES

A. Construct asphalt concrete dikes per SDARSD G-5, Type A at the locations shown on the Plans.

END OF SECTION
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PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes materials and installation of ductile-iron pipe and fittings. Use ductile iron pipe and fittings for blowoff discharge piping as shown on the Plans.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02200 Earthwork

B. Section 09900 Painting and Coating

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American National Standards Institute

B16.1 Cast Iron Pipe Flanges and Flanged Fittings.

B16.42 Ductile Iron Pipe Flanges and Flanged Fittings, Classes 150 and 300.

B. American Society for Testing and Materials

A47 Ferritic Malleable Iron Castings.

A183 Carbon Steel track Bolts and Nuts.

A536 Specification for Ductile Iron Castings.

D16 Terminology Relating to Paint, Varnish, Lacquer and Related Products.

D2000 Standard Classification System for Rubber Products in Automotive Applications.

B. American Society for Testing and Materials

A47 Ferritic Malleable Iron Castings.

A183 Carbon Steel track Bolts and Nuts.

A536 Specification for Ductile Iron Castings.

D16 Terminology Relating to Paint, Varnish, Lacquer and Related Products.

D2000 Standard Classification System for Rubber Products in Automotive Applications.

C. American Water Works Association

C104 Cement Mortar Lining for Ductile-Iron Pipe and Fittings for Water.

C105 Polyethylene Encasement For Ductile-Iron Pipe Systems.

C110 Ductile-Iron and Gray-Iron Fittings, three inch Through 48 inch, For Water and Other Liquids.


C115 Flanged Ductile-Iron Pipe with Threaded Flanges.

C150 Thickness Design of Ductile-Iron Pipe.

C151 Ductile-Iron Pipe, Centrifugally Cast, For Water and Other Liquids.

C153 Ductile-Iron Compact Fittings, three inch through 24 inch and 54 inch through 64 inch.

C210 Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
C600 Installation of Ductile-Iron Water Mains and their Appurtenances.

C606 Grooved and Shouldered Joints.

1.04 SUBMITTALS

A. Pipeline layout drawings showing location and dimensions of pipe, fittings and specials. Include laying lengths of valves, meters, and other equipment determining piping dimensions. Label or number each fitting or piece of pipe. Include a tabulated layout schedule showing the following:

1. Pipe station and top of pipe elevation at each change of grade and alignment.
2. Elements of curves and bends, both in horizontal and vertical alignment, including elements of the resultant true angular deflections in cases of combined curvature.
3. The limits of each reach of pipe pressure class and of restrained joints.
4. The limits of each reach of concrete encasement or encasement in casing.
5. Locations of closures for length adjustment and for construction convenience.
6. Locations of valves and other mechanical equipment.
7. Show deflections at push-on, restrained push-on, and mechanical joints.
8. Show mortar lining thickness.

B. Joint details.

C. Calculations and/or test data proving that the proposed restrained joint arrangement can transmit the required thrust.

D. Copy of manufacturer's quality control check of pipe material and protection.

E. Test report on physical properties of rubber compound used in the gaskets conforming with AWWA C111.

1.05 INSPECTION AND FIELD VERIFICATION

A. The Engineer may inspect materials, productions, and testing of pipes, fittings, and special pieces at manufacturer's plant.

B. Where new pipelines are to be connected to existing Water Authority pipelines, field verify the location, elevation, pipe material, pipe outside diameter, and any other characteristics of the existing pipeline before proceeding with the installation. Perform the field verification in the presence of the Engineer.

PART 2 - MATERIALS

2.01 DUCTILE IRON PIPE AND FITTINGS

A. Use ductile iron pipe specified by pressure class in accordance with AWWA C151, unless otherwise indicated. Provide pipe in pressure classes at locations and in lengths as shown on the Plans.

B. For fittings 24 inch and smaller, use ductile iron fittings conforming to AWWA C110 or C153, with a minimum rated working pressure of 350 psi.
C. For fittings smaller than 54 inch but larger than 24 inch, use ductile iron fittings conforming to AWWA C110 with a minimum rated working pressure of 250 psi.

D. For grooved or shouldered joints, use ductile-iron fittings conforming to AWWA C110 and ANSI B16.42. Groove or shouldered joints shall conform to AWWA C606.

2.02 PIPE WALL SPECIAL CLASSES

A. Special classes for ductile iron pipe shall be in accordance with AWWA C151. Minimum wall thickness for pipe having grooved end joints shall be in accordance with the following table, unless otherwise noted on the Plans:

<table>
<thead>
<tr>
<th>Pipe Fitting Size (in.)</th>
<th>Wall Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 and smaller</td>
<td>Special Class 53</td>
</tr>
<tr>
<td>18</td>
<td>Special Class 54</td>
</tr>
<tr>
<td>20</td>
<td>Special Class 55</td>
</tr>
<tr>
<td>24 and larger</td>
<td>Special Class 56</td>
</tr>
</tbody>
</table>

B. Minimum wall thickness for pipe having threaded flanges shall be Special Class 53 per AWWA C115 and AWWA C151.

2.03 JOINTS

A. Joints in above ground piping or piping located in vaults and structures shall be flanged per AWWA C115, unless mechanical clamp-type couplings or flange adapters are shown on the Plans.

B. Joints in buried piping shall be of the restrained push-on, push-on, or mechanical joint type per AWWA C111, except where flanged joints are required to connect to valves, meters, and other equipment. Provide unrestrained buried joints except where restrained joints are specifically shown on the Plans. The restrained push on joints are to be boltless, and the use of set screws in a mechanical joint retainer gland system shall not be allowed. Restrained push-on joints shall provide deflection after assembly. Restrained push-on joints shall be American Cast Iron Pipe Company "Flex-ring", "Lok-Ring", or "Lok-Fast"; U.S. Pipe "TR Flex"; or equal. Push-on joints shall be American Cast Iron Pipe Company "Fastite", U.S. Pipe "Tyton", or equal.

2.04 FLANGES

A. Use flat faced ductile iron flanges conforming to AWWA C110, C115 and ANSI B16.42, Class 150 or 300. For working pressures and maximum hydraulic gradients of 200 psi and less, use AWWA C110 and Class 150 flanges. For working pressures and maximum hydraulic gradients of greater than 200 psi, but less than 300 psi, use Class 300 flanges.

2.05 BOLTS, NUTS, AND GASKETS

A. Bolts, nuts, and gaskets for mechanical and push on type joints shall conform to AWWA C111. Gaskets shall be of such size and cross section as to completely fill the groove and provide a watertight seal under all conditions of design pressure and allowable joint deflection.

B. Nuts, bolts, washers, and gaskets for flanged pipe and fittings shall conform to Section 15000, Piping Schedule and General Piping Requirements.

2.06 MECHANICAL CLAMP-TYPE COUPLINGS AND FLANGE ADAPTERS

A. Mechanical clamp-type couplings and flange adapters for grooved or shouldered end pipe shall be malleable iron, ASTM A47 Grade 32510, or ductile-iron, ASTM A536 Grade 65-45-12. Bolts shall conform to
ASTM A183, 100,000 psi tensile strength. Gaskets shall be halogenated butyl rubber or EPDM conforming to ASTM D2000.

B. Couplings for pipe, 24 inches and smaller, shall conform to AWWA C606 for rigid, radius cut grooved joints in ductile iron pipe. Couplings shall be Victaulic Style 31, Gustin-Bacon No. 500, or equal.

C. Couplings for pipe, larger than 24 inches, shall conform to AWWA C606 for shouldered end pipe. Couplings shall be Victaulic Style 44 or equal.

D. Grooved end flange adapters for piping having an operating pressure of 150 psi and less shall be Victaulic Style 341, or equal. Flange dimensions shall conform to ANSI B16.1.

2.07 CEMENT MORTAR LINING

A. Where shown on the Plans, line pipe interior and fittings with cement mortar and seal coat in accordance with AWWA C104. Provide double thickness lining and use cement conforming to ASTM C150, Type II.

2.08 POLYURETHANE LINING

A. Line pipe interior and fittings with polyurethane lining where shown on the Plans. The polyurethane lining material shall consist of a polyisocyanate resin and polyol resin mixed in a 1:1 ration at the time of application. The mix shall conform to ASTM D 16 Type V system and shall be black standard color. The lining shall be Madison Corropipe II PW, or equal.

B. Repair and touchup materials shall be Madison Corropipe II Mastic, Madison Corropipe II PW-Touchup, or equal.

2.09 PIPE COATINGS

A. Coat exterior surfaces of pipe located indoors, in valves and structures, and above ground in accordance with Section 09900, Painting and Coating. Apply finish coats in field.

B. Coat exterior of buried pipe and fittings with a bituminous outside coating in accordance with AWWA C151 for pipe and AWWA C110 for fittings.

C. Polyethylene encasement shall be furnished and installed on all buried ductile iron pipe and fittings in accordance with AWWA C105.

PART 3 - EXECUTION

3.01 APPLICATION OF POLYURETHANE LINING

A. All surfaces to be lined shall be cleaned to a near white metal finish (SSPC-SP10) as applied to ductile iron pipe and fittings. All surfaces to be coated shall be completely dry, free of moisture, dust, grease, or any other deleterious substances, at the time the coating or lining is applied.

B. Thickness. The dry film thickness of internal linings shall be 40 mils nominal. Thickness determinations using a Type 1 magnetic thickness gage shall be conducted in accordance with SSPC-PA2 as applied to ductile iron pipe and fittings. Measure the lining thickness at three locations on each pipe section using the coating thickness gauge. Record each measured thickness value. Where individual measured thickness values are less than the specified minimum thickness, measure the lining thickness at three-foot intervals along the pipe length. The average of these measurements shall exceed the specified minimum thickness value, and no individual thickness value shall be more than two mils below the specified minimum value. If a section of pipe does not meet these criteria, remove the entire lining and reline the entire pipe section or fitting.
C. Joints. The coating thickness on sealing areas in the bell socket interior and on the spigot end of the pipe exterior shall be eight mils nominal with a maximum of ten mils. Thicker coatings in these areas are acceptable if it is demonstrated that joint dimensions are within ductile iron pipe allowable tolerances after coating. The joint coating material shall be Madison Corropipe II PW, or equal.

D. Repair and Field Touchup. Repairs and touchup shall be performed in accordance with the manufacturer’s recommended repair and touchup procedures. Patched areas shall overlap the parent or base coating a minimum of 1/2 inch. If defective area exceeds 40 square inches, remove the entire lining and reline the entire pipe section or fitting. All field cut ends shall be repaired and sealed prior to installation.

E. Appearance. The finished polyurethane shall be generally smooth and free of sharp protuberances. A minor amount of sags, dimpling and “curtaining” which otherwise meets the specification requirements shall not be considered cause for rejection.

F. Testing. Holiday inspection shall be conducted with a low-voltage wet sponge holiday detector in accordance with AWWA C210. If the number of holidays or pinholes exceeds one per ten square feet, remove the entire pipe lining and reline the entire pipe or fitting. In accordance with lining manufacturer’s recommendation, holiday testing may be conducted any time after the lining has reached sufficient cure.

3.02 PIPE INSTALLATION

A. Install ductile iron pipe and fittings in accordance with AWWA C600, and as described herein.

B. When pipelaying is not in progress, close the ends of the installed pipe by a vermin and child proof plug.

C. Trench excavation, compaction, and backfilling shall be in accordance with Section 02200, Earthwork.

D. Inspect each pipe and fitting before lowering into the trench. Inspect the interior and exterior protective coatings. Patch damaged areas in the field with material similar to the original. Clean ends of pipe thoroughly. Remove foreign matter and dirt from inside of pipe and keep clean during and after laying.

E. Handle pipe in a manner to avoid any damage to the pipe. Do not drag pipe over the ground, drop it onto the ground, or drop objects on it. Do not drop or dump pipe into trenches under any circumstances.

F. Laying tolerances for the installed pipe shall not vary greater than 0.3 foot horizontally, or greater than 0.1 foot vertically from the alignment and elevations shown on the Plans.

G. At the location of each joint, dig bell holes in the bottom of the trench and at the sides to permit visual inspection of the entire joint and to prevent the pipe from being supported by the bell end or fitting.

H. Install polyethylene encasement on pipe and tape end joints.

3.03 INSTALLING FLANGED PIPE AND FITTINGS

A. Inspect gasket seating surfaces, gasket, each stud or bolt, each nut, each washer, and the facing on which the nuts will rotate. Replace any damaged item.

B. Assemble all bolts in flange, then tighten bolts in sequence and to the torque recommended by the manufacturer. Replace galled, cracked, or distorted bolts and nuts. Do not reuse bolts, nuts, or gaskets.

C. Coat buried flanges per Section 09900, Painting and Coating, System No. 21 and System No. 24.

3.04 INSTALLING MECHANICAL CLAMP-TYPE COUPLINGS OR FLANGE ADAPTERS

A. Install grooved or shouldered end pipe and fittings in accordance with the coupling or adapter manufacturer's recommendations and the following.
B. Clean loose scale, rust, oil, grease, and dirt from the pipe or fitting groove or shoulder before installing coupling or adapter. Apply the coupling manufacturer's gasket lubricant to the gasket exterior including lips, pipe ends, and housing interiors.

C. Fasten coupling alternately and evenly until coupling segments are seated. Use torque's as recommended by the coupling manufacturer.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section describes materials and fabrication of welded steel pipe, with fittings and pipe specials, in accordance with AWWA C200, as modified herein.

B. A special is defined as any piece of pipe other than a normal full length of straight section pipe. This includes elbows, manhole sections, short pieces, reducers, adapter sections with special ends, sections with outlets, etc.

C. Except where otherwise specified or shown, steel pipelines shall be cement mortar lined.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01530 Protection of Existing Facilities
B. Section 02655 Installation of Pipe
C. Section 09870 Plant-applied Cement Mortar Lining
D. Section 09871 Cement Mortar Coating
E. Section 09872 Coal-Tar Coating
F. Section 09873 Cold-Applied Plastic Tape Coating
G. Section 09874 Fusion-Bonded Epoxy Lining and Coating
H. Section 09900 Painting and Coating
I. Section 15000 Piping Schedule and General Piping Requirements
J. Section 15122 Pipe Couplings and Expansion Joints

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American National Standards Institute
   B16.1 Cast Iron Pipe Flanges and Flanged Fittings.
   B16.5 Pipe Flanges and Flanges Hinges.
   B36.10 Welded and Seamless Wrought Steel Pipe.

B. American Society for Testing and Materials
   A36 Specification for Structural Steel.
   A53 Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
   A105 Specification for Forgings, Carbon Steel, for Piping Components.

A181 Specification for Forgings, Carbon Steel, for General-Purpose Piping.

A234 Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.

A283 Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.

A570 Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality.

E165 Practice for Liquid Penetrant Inspection Method.

E709 Practice for Magnetic Particle Examination.

C. American Water Works Association

C200 Steel Water Pipe Six Inch and Larger.

C207 Steel Pipe Flanges for Waterworks Service-Sizes Four Inch through 144 inches.

C208 Dimensions for Fabricated Steel Water Pipe Fittings.


D. American Welding Society

AWS D1.1 Structural Welding Code, Steel.

1.04 QUALIFICATIONS OF MANUFACTURERS

A. Submit qualifying experience for all pipe manufacturer processes and include all manufacturers, fabricators and subcontractors retained by the Contractor to manufacturer the pipe complete with the required plant-applied pipe linings and coatings. Plant-applied pipe linings and coatings, whether applied at the factory by the pipe manufacturer or by specialty lining and coating subcontractors under the direct supervision of the pipe manufacturer, is an element of the completed pipe. Qualifying experience for pipe fabrication shall include a minimum of three projects completed or in current fabrication within the past six years with similar pipe diameters, plate thickness, and quantities of steel as required by the Work shown on the Plans. Qualifying experience for plant-applied pipe linings and coatings shall include a minimum of three projects completed or in current fabrication within the past six years with the same linings and coatings as required by the Work shown on the Plans. Qualifying experience for plant-applied cement mortar coating may include application of cement mortar over a dielectric coating or on bare steel pipe.

B. For each qualifying project, submit the following information: project name, project owner, current owner contact information (contact name, mailing address, email address, telephone number, and fax number), project size (diameter, plate thickness, length of pipe or tons of steel), type of service, type of lining and coating, and year pipe was manufactured. All project information will be verified by the Engineer.

1.05 SUBMITTALS

A. Prepare Shop Drawings consistent with the pipeline alignment and grade shown on the Plans, and with the size, location, elevation and slope information of existing utilities, pipelines and encasements obtained by the
Contractor in accordance with Section 01530, Protection of Existing Facilities and Section 02655, Installation of Pipe. The pipeline Shop Drawings shall include:

1. The location, length, plate thickness, and designation by number of each steel pipe section and fabrication.

2. The invert station and elevation to which the spigot end of each pipe, within the limits of horizontal or vertical curve, will be laid.

3. The elements of curves and bends, both in horizontal and vertical alignment, including elements of the resultant true angular deflections in cases of combined curvature.

4. The limits of each reach of each type of field-welded joint and of concrete encasement.

5. Locations of longitudinal and circumferential joints in the pipe, fabricated fittings, and outlets.

6. Details, locations and calculations for bulkheads, pipe restraint and all methods required to prevent excessive pipe wall stresses for hydrostatic testing of pipeline.

7. Details and locations of closures for length adjustment and for construction convenience.

8. Details of specials and fittings.

9. Details of all valves, meters, pumps and other equipment determining pipe dimensions.

10. Details of butt straps which are to be shipped separately.

B. Certified copies of mill test reports on each heat from which steel is rolled. Tests shall include physical and chemical properties. Submit certified copies of mill test reports for flanges including details of stress relief used.

C. Weld procedure specifications, procedure qualification records including all destructive and non-destructive test results and welding bead profiles as required along with individual welder qualification certificates. The Engineer shall be present during qualification of weld procedure.

D. Certificates of welding rods used for shop and field welding. Submit welding procedure specifications including drawings of bevel surfaces to be automatically welded and procedure qualification records.

E. Test reports on physical properties of rubber used in the gaskets.

F. Points of access and schedule for placement of mortar lining and removal of test bulkheads.

G. Affidavits of compliance with referenced standards (e.g., AWWA C200, C207, etc.) with each required submittal.

H. Within 30 days following the Notice to Proceed and prior to the submittal of any shop drawing for pipe, pipe coating or pipe lining, the pipe manufacturer shall submit a detailed Pipe Fabrication Plan and Quality Control Program Manual for each pipe fabrication plant, as described below. Failure to submit, implement, and adhere to the submitted Pipe Fabrication Plan and the Quality Control Program Manual will be reason to reject delivery of steel pipe. Do not manufacture any pipe until the Pipe Fabrication Plan and Quality Control Program Manual have been reviewed and accepted by the Engineer.

1. Pipe Fabrication Plan providing a description of the actual steel pipe fabrication process covering all phases of fabrication to finish pipe. The Pipe Fabrication Plan shall include, as a minimum, the following:
a. Qualifications of plant staff directly involved in this Contract, including qualifications of welders.

b. Current and anticipated workload of the plant. State how other work will affect the fabrication schedule for this Contract.

c. Plant quality control recordkeeping, and means for transmittal to the Engineer's in-plant inspectors.

d. Shop drawing submittal process.

e. Sources of materials, and plant quality control procedures regarding these materials.

f. Schedule of material delivery to the plant.

g. Fabrication schedule.

h. Material, pipe handling and storage at the plant.

i. Steel fabrication process.

j. Welding procedures.

k. Physical testing methods and procedures for the steel pipe and welds.

l. Coating and lining materials and procedures.

m. Curing methods.

n. Repair methods and limits of repairs.

o. Bracing Plan.

p. Shipping and transportation methods from the plant to the job site.

q. Storage and handling of pipe at the job site.

2. Quality Control Program Manual providing hold points, documentation, staffing, and appropriate sign-off regarding adherence to the Contract Documents. Include a system for documenting the pertinent information for each pipe section. Complete documentation as each pipe section is fabricated, and a copy shall accompany the pipe section to the job site. Include certification of Compliance with the Contract requirements as part of the Quality Control Program Manual.

I. Provide 30 day written notice to start of pipe fabrication.

J. Within 30 days following completion of pipe fabrication, submit mill test reports on each heat, dimensional check report, shop hydrostatic test report, and results of production weld test for each pipe section by mark number. Certify each report. Include a summary list cross referencing heat numbers and pipe shop numbers with pipe mark numbers.
PART 2 - MATERIALS

2.01 DESIGN CRITERIA

A. Obtain the following information from the Plans:

1. Elevation of the pipe invert and of the final ground surface.
2. Alignment of the pipeline.
3. Nominal internal diameter, after lining.
4. Pipe wall thickness and welded steel pipe cylinder internal diameter.
5. Locations of double-welded and butt-welded joints.
6. Design Hydraulic Grade Line.

B. The proportioning and detailing of fabricated fittings, manholes, outlets, and pass holes, and the fabrication thereof, shall be performed in accordance with the requirements of the latest edition of the ASME Boiler and Pressure Vessel Code, Section VIII, Pressure Vessels; provided, that if the details shown on the Plans are better suited for the work, in the opinion of the Engineer, such details shall be controlling. Where not detailed on the Plans, the design of wyes, tees and fitting reinforcement shall be in accordance with the applicable procedures of AWWA Manual M11.

2.02 SHEET STEEL OR PLATE AND MINIMUM YIELD POINT

A. Fabricate steel pipe, appurtenances and fittings from steel sheet, plate, or coil that conforms to ASTM A283, Grade D, ASTM A1018 Grade 33 or ASTM 1011 Grade 33. Steel plates or coils shall be fine grained, fully kilned, and manufactured using a continuous casting process. The maximum carbon content shall not exceed 0.25 percent. The maximum sulfur content shall not exceed 0.015 percent. The steel shall also meet a maximum carbon equivalent of 0.45, calculated as follows:

\[
CE = C + \frac{(Mn + Si)}{6} + \frac{(Cr + Mo + V)}{5} + \frac{(Ni + Cu)}{15}
\]

B. Arrange the fabricated pipe sections such that adjoining pipe sections have a yield strength variation of no greater than five ksi.

C. Order the steel plate and sheet by thickness with a maximum allowable variation of not more than 0.01 inch less than the thickness specified. Do not substitute thicker plate without the Engineer’s approval. Tests performed on two-inch tension specimens shall show elongations not less than 22 percent.

D. Test steel 3/8 inch and greater in thickness for notch toughness using the Charpy V-Notch test. The steel shall withstand a minimum impact of 25 ft lb at a temperature of 30 degrees F. Test each heat of steel by taking one specimen from any two coils per heat number and test in accordance with ASTM A370.

E. The cold working of steel plate to obtain the specified tensile requirements will not be permitted. Any laminations or other defects will be cause for rejection.

2.03 STRUCTURAL STEEL FOR OUTLET REINFORCEMENT

A. Conform to the requirements of ASTM A36.
2.04 MILL-MANUFACTURED STEEL PIPE

A. Size range for mill manufactured pipe is two inch through 36 inch.

B. Fabrication of mill manufactured steel pipe shall conform to the requirements of AWWA C200. Pipe shall be fabricated from steel sheet, to ASTM A570, grade 33 (33,000 psi) or grade 36 (36,000 psi), or from steel plate to ASTM A283, grade D (33,000 psi) or ASTM A36 (36,000 psi).

C. Alternatively, pipe shall conform to the requirements of ASTM A53, Type E or S, Grade B, or ASTM A106, Grade B. Pipe shall be standard weight in accordance with ANSI B36.10, unless otherwise shown on the Plans, and shall meet dimensional requirements of ASTM A53 for diameters up to 26 inches and ANSI B36.10 for diameters larger than 26 inches.

2.05 FLANGES

A. For design pressures up to and including 275 psi, use AWWA Class E steel flanges, or use ANSI B16.5, Class 150 steel flanges.

B. For design pressures exceeding 275 psi, use ANSI B16.5, Class 300 steel flanges for pipe diameters up to and including 24 inches. Use ASME B16.47, Class 300 steel flanges for pipe diameters 26 through 36 inches.

C. Cast iron flanges shall conform to ANSI B16.1, Class 125 or Class 300.

D. Flanges fabricated from steel plate shall meet the requirements of ASTM A516, Grade 70. Forgings shall meet the requirements of ASTM A105. Castings shall meet the requirements of ASTM A216 WCB.

E. Flange bolts, nuts, gaskets, flange insulation kits and unions, shall be in accordance with Section 15000, Piping Schedule and General Piping Requirements.

F. For flanges where an insulating kit will be installed, the pipe flange and valve flange bolt holes shall be oversized an additional 1/8 inch per AWWA C207, Section 4.2.3 to accommodate the insulating sleeves according to the following schedule:

1. Pipe diameters less than 36 inches: Oversized flange bolt holes are not required. Holes shall be drilled the normal 1/8-inch larger than the nominal bolt diameters.

2. Pipe diameters between 36 inches and 84 inches: The flange bolt holes diameters shall be 1/4 inch larger than the nominal bolt diameters.

3. Pipe diameters larger than 84 inches: The flange bolt holes diameters shall be 5/16-inch larger than the nominal bolt diameters.

2.06 JOINTS

A. Provide bell and spigot pipe ends for field welded joints, except where butt-strap joints, butt-welded joints, or flanged joints are used.

B. Joints for piping located above ground or in vaults and structures shall be flanged, threaded, or grooved end as shown on the Plans. Grooved and shouldered joints shall be in accordance with Section 15122, Pipe Couplings and Expansion Joints.

C. Provide plain-end pipe for flexible pipe couplings. Provide thrust harnesses where shown on the Plans in accordance with Section 15122, Pipe Couplings and Expansion Joints. Harness lugs shall be welded to the pipe prior to coating.
D. Where piping connects to wall pipes, meters, valves, or other equipment, match the pipe ends to the ends of the wall pipes, meters, valves, or equipment.

E. Joints for buried blow-off outlet piping fabricated as epoxy lined and coated steel pipe shall be field welded, bell and spigot joint. Provide a threaded opening at each welded joint for repairing of the epoxy lining.

2.07 FITTINGS

A. Except where detailed on the Plans, fabricated steel fittings shall be in accordance with AWWA C208. Reinforcement of fittings shall be in accordance with AWWA M11.

2.08 WELDING FITTINGS

A. Provide butt-welded wrought carbon steel fittings conforming to ASTM A234, Grade WPB. Minimum thickness shall equal the thickest matching pipe.

2.09 PIPE JOINT COMPOUND

A. Use American National Taper pipe threads on all threaded joints. Apply joint compound to the male threads only. Pipe Joint compound shall be Teflon thread sealant Bakerseal by Radiator Specialty Company, La-Co SlicTite by Lake Chemical Company, or equal.

2.10 THREADED OPENINGS

A. Provide threaded openings not less than two inches, nor more than four inches in nominal size. Threaded openings shall be a standard weight, flat-bottom, threaded welding outlet. Where the mounting surface is curved to a diameter of 36 inches or less, the mounting diameter shall be the same as that of the surface upon which it is to be mounted.

B. Provide threaded outlet and its plug forged from steel conforming to ASTM A105 or ASTM A181, Class 70. Provide weldolet outlets.

2.11 WELDING OUTLETS

A. Provide welding-type outlets with a mounting diameter the same as that of the surface upon which they are to be mounted. Where the mounting surface is curved to a diameter of 36 inches or more, the outlet bottom may be flat. Provide welding-type outlets forged from steel conforming to the requirements specified for threaded outlets. Provide weldolet outlets.

PART 3 - EXECUTION

3.01 DIAMETER AND LENGTH OF PIPE SECTIONS

A. The nominal diameter or inside diameter of the pipe and other fabricated steel sections as shown on the Plans is the clear diameter of the lined pipe after the application of interior mortar lining. For epoxy lined pipe, the diameter shown on the Plans shall be considered the minimum inside diameter of the pipe.

B. The length of standard sections of pipe shall be from 30 to 40 feet, except within tunnels where standard sections may be up to 50 feet in length.

C. The minimum length of closure and correction pieces shall be four feet.

D. Do not locate closure lap joints, field joints, or field closure assemblies within four feet of the end of a concrete encased section of pipe. Do not locate closure lap joints or field closure assemblies within a concrete encased section of pipe. Concrete encased pipe sections are located around manholes, outlets, and at other locations as shown on the Plans.
A. Longitudinal and Girth Seams: Fabricate the pipe cylinder by butt welding, spiral seam, or straight seam. When using straight seams, fabricate pipe with either a single longitudinal seam and multiple courses of, from seven feet six inches to ten feet, or else with a single course having not more than the number of longitudinal seams shown in the table listed below. Where more than one longitudinal seam is used, the plates shall be of equal widths. Equally stagger the longitudinal joints of adjacent courses. When using spiral seams, coil splices shall be a minimum of two feet away from the ends of the pipe cylinder.

<table>
<thead>
<tr>
<th>Pipe Nominal Diameter (in.)</th>
<th>No. of Seams</th>
</tr>
</thead>
<tbody>
<tr>
<td>36 to 60</td>
<td>2</td>
</tr>
<tr>
<td>61 to 90</td>
<td>3</td>
</tr>
<tr>
<td>91 to 120</td>
<td>4</td>
</tr>
</tbody>
</table>

B. Preparation of Edges

1. Machine or face the ends and edges of plates for butt welds. Inspect sheared edges of plates or sheets over 1/4 inch in thickness for cracks. Do not use plates or sheets with edges containing cracks. If the ends are faced with a cutting torch, remove irregularities and scale due to burning by grinding or chipping. The dimensions and shape of the edges of the plates to be joined by welding and the gap between the plates shall be such as to allow thorough fusion and complete penetration, and the edges of plates shall be properly formed to accommodate the various welding conditions. Limit the maximum gap between the edges of plates prior to welding to not more than 1/16 inch.

2. Remove projecting burrs. Do not use hammering to shape the edges preparatory to welding. Cut plates true to line so that the edges, when in position for welding, are straight, parallel, and in contact on longitudinal seams.

C. Forming Steel Plate or Sheet

1. Before rolling or forming longitudinal edges, lap break the plate edges by a continuous rolling operation or forming in a press having dies that are machined to the proper radius. Exert sufficient pressure during the lap breaking operation to obtain a true and uniform curve at the edges of the plate. Roll or press form plates to the specified diameter. Continually remove scale and other foreign matter accumulating on the plate during the rolling and forming operation by an air blast so that it will not be rolled or pressed into the surface of the plate.

2. Keep the surfaces of breaker dies and rolls clear of bits of metal or other accumulated materials during forming operations. Form each section of pipe to a true circle of the specified diameter throughout its entire length so as to produce a finished pipe truly round and free from dents, kinks, and abrupt changes in curvature.

3. The outside circumference of the finished pipe shall not be less than its design value and shall not exceed its design value by more than 0.4 percent. Complete rolling and forming prior to making butt welds. Do not heat or hammer for the necessary forming of angles.

4. Do not use any forming process in which the plates are bent or otherwise formed during any stage of the process to a curvature of appreciably smaller radius than the radius of curvature corresponding to the specified diameter of the pipe.
D. Forming Bells

1. Shape the bells to accommodate the spigot penetration shown on the Plans or specified herein. Form the bell on an expanding press or by being thrust axially over a die in such a manner as to stretch the steel plate beyond its elastic limit to a round bell of required diameter and shape, avoiding injurious reduction in plate thickness at any point, and avoiding impairment of the physical properties of any part of the plate. Do not use any process in which the bell is formed by rolling.

2. Bells for mitered pipe shall be normal to the axis of the adjacent course of the adjoining pipe, and the axis of any such bell shall be parallel to the axis of such adjacent course. The interior circumferential length of the bell shall be greater than the exterior circumferential length of the pigot, and the difference between circumferential lengths shall not exceed 1/4 inch.

E. Preparation for Welding

1. Take special care in the layout of joints in which fillet welds are to be used in order to ensure the fusion of the weld material at the bottom of the fillet. Prior to welding, fit the plates closely; and during welding, hold them firmly together. Tack weld or clamp in place the edges of butt joints in proper alignment and so hold throughout the welding process. Do not use dogs, clips, lugs, or equivalent devices welded to the steel plate for the purpose of forcing it into position.

2. Prior to welding, clean the surfaces of plates and members to be welded by an automatic process of all scale and rust for a distance of not less than one inch and of all oil or grease for a distance of not less than three inches from the welding edge and on both sides of the plates in the case of butt joints. Remove grease or oil with lye or other solvent. Do not use kerosene or any heavier petroleum solvent.

3. Blasting and other cleaning shall preferably be done prior to any tack welding of the plates. Should inspection indicate a greater amount of porosity at the tack welds than in the remainder of the welds, sandblast the tack welds prior to automatic welding.

4. When it is necessary to deposit metal over a previously welded surface, remove any scale, slag, or welding flux thereon by a roughing tool, chisel, air chipping hammer, or other means to prevent inclusion of impurities in the weld metal.

5. Where butt-welded joints are used, take particular care in aligning the edges to be joined so that complete penetration and fusion at the bottom of the joint is accomplished. The offset in abutting edges shall not exceed 1/16 inch at circumferential and spiral seams and shall not exceed 1/32 inch at longitudinal seams.

6. For plates over 1/2 inch thickness, if thickness of the two adjacent plates are different by more than 1/8 inch, the thicker plate shall be trimmed to a smooth taper extending for a distance of at least four times the offset between abutting surfaces so that the adjoining edges will be approximately the same thickness. The length of the required taper may include the width of the weld.

F. Welding

1. Perform all welding in accordance with AWS Standards, and as provided herein.

2. Perform welding by an unvarying arc-welding process, which excludes the atmosphere during the process of deposition and while the metal is in a molten state. The size and type of electrode used, the current and voltage required, and the type of wire and flux to be used for automatic processes shall be subject to review by the Engineer. Do not use rusted or damaged electrodes. Sift used flux from automatic welders free of fines and coarse pieces and remove mill scale before reusing.
3. Welds shall be of uniform composition, neat, smooth, full strength, and ductile. Make welds with a technique which will ensure uniform distribution of load throughout the welded section with a minimum tendency to produce eccentric stress or distortion in the weld or in the adjacent metal.

4. Make all welds in such manner and on such time schedule as to avoid residual internal stresses in the welded joints and stresses due to temperature changes in the completed pipelines. Weld longitudinal seams before girth seams.

G. Longitudinal Joints

1. Double butt weld by a fully automatic welding process longitudinal joints using welding heads which permit visual investigation of the deepest point of penetration of the first pass and which permit backfilling of extensive repair cuts by the automatic process. Use starter and runoff plates for longitudinal welds. The first pass on longitudinal welds shall be on the inside of the pipe and accomplish at least 75 percent of the land. Land is defined as the non-beveled portion of the pipe face along the edge of pipe. Do not use runoff plates for weld test coupons.

2. Joint welds shall be continuous for the full length of the seam, and shall be built up uniformly at the center of the weld to form a reinforcement on both sides of the plate. The bead on the outside of the pipe shall have a height of at least 1/16 inch and a minimum width of at least one and one-half times the thickness of the plate; provided that in any case the weld and penetration shall be of sufficient width so that both edges to be joined shall be entirely involved in the weld, regardless of a possible inaccuracy in the line of travel of the automatic electrode. Where the welding method permits a considerable deviation in the line of travel of the welding head, place a scribed line parallel to and at a fixed distance from the edges of the plates prior to welding so that the location of the welding bead with regard to the plate joints may be readily checked.

3. Where welding is done from one side only, remove the bead on the inside of the pipe by chipping so that the finished weld on the inside of the pipe will be practically flush with the plates. The inside bead will in no case be required to be larger than the outside bead but shall be of sufficient size so that upon its removal, the inside fusion lines and any defects near the under surface of the weld metal will be exposed.

4. If complete penetration and reinforcement on both sides of butt-welded joints are not satisfactorily accomplished, when the welding is done from one side, then chip out the reverse side to the extent necessary to secure a clean surface of the originally deposited weld metal and make an automatic welding pass on the reverse side. The bead on the inside of the pipe shall be not more than 3/32 inch in height and the width of the bead shall be not less than 3/8 inch with smoothly tapered edges. Before making the second weld, chip out the under-side of the first weld with a round-nosed tool until entirely solid and clean metal is reached.

5. Welding shall be subject to the requirement that there shall be no valley, groove, or undercut along the edge of or in the center of the weld, and that the deposited metal shall be fused smoothly and uniformly into the plate surface at the edges of the joint.

6. If the normal welding process is interrupted for any reason, take special care when welding is resumed, to get full penetration and thorough fusion between the weld metal and the plates and the weld metal previously deposited. Where welding is interrupted by faulty machine operation, chip back the weld to where the presence of solid, clean metal indicates correct machine operation before resuming welding operations.

H. Shop Circumferential Joints and Spiral Seam Joints

1. Double butt weld shop circumferential and spiral seam joints. The details of shop circumferential and spiral seam joints shall conform to the requirements for longitudinal joints as given above.
Circumferential joints in bends and welded fabricated fittings need not be made by automatic welding methods.

I. Quality of Welds

1. There shall be no greater evidence of oxidation in the metal of the weld than in the metal of the unwelded plate. Welded joints shall be of a type that will produce complete fusion of the plates and shall be free from unsound metal, pinholes, and cracks.

2. The finish of welded joints shall be reasonably smooth and free from grooves, depressions, burrs, and other irregularities. There shall be no valley or undercut in the center or edges of any weld.

3. Any pipe section which shows irregularities in shape after welding may be rerolled to make it cylindrical, but in no case shall it be reformed by hammering, and in no event shall reforming be permitted of pipe sections which after welding are found to have abrupt changes in curvature at longitudinal seams, unless such welds are subsequently removed and rewelded following the reforming operation.

4. Back chipping on both automatic and hand welding, whether for repairs or preparation of the groove for the original weld, are subject to inspection by the Engineer before being filled with weld metal. Do not make butt welds prior to the completion of the rolling and forming. Grind butt welds for both hand and automatic welding to sound metal before welding the reverse side.

J. Defects

1. Completely remove porosity and cracks, trapped welding flux, or other defects in the welds in a manner which will permit proper and complete repair by welding. After removing the defect, the area shall be inspected by the Engineer using liquid penetrant or magnetic particle test method. Repair defective welds by hand welding. Where the defect is so extensive as to make a hand repair undesirable, use automatic welds. If the percent of the weld defect exceeds 10 percent for longitudinal seams or 5 percent of spiral seams the pipe section shall be rejected and removed from the job rather than reworked.

K. Equipment

1. In welding by an automatic process, both the rate of deposition of weld metal and the rate of travel of the electrode shall be automatically controlled. Use the submerged melt process for automatic welding.

3.03 JOINTS

A. When plate flanges are made from butt-welded segments, do not place the joints between segments adjacent to longitudinal joints in adjoining steel plate sections. Stress-relieve flanges made from butt-welded segments.

B. Furnish forged steel slip-on flanges or welding neck flanges for companion flanges and connections. Blind flanges, reducing flanges, special flanges, and flanges which are greater in diameter than 24-inch nominal pipe size may be made of plate.

C. For drilling of bolt holes of insulating flanges not dimensioned on the Plans, prepare flange bolting as recommended by the insulating sleeve manufacturer.

3.04 SHOP TESTING

A. After completion of fabrication and welding in the shop, and prior to the application of any lining or coating, test each component according to the following requirements.
1. Test each section of steel pipe in the shop at which it is manufactured by the hydrostatic test method.

2. Except as otherwise shown or specified, test each completed section of fabricated bend or reducer using the hydrostatic test method. If the bend or reducer is fabricated from steel pipe previously tested, retest the completed bend or reducer by hydrostatic test method or use the radiographic or ultrasonic test methods on all non-hydrostatically tested welds. Sections requiring mitering on the ends may be tested by hydrostatic test method before mitering. Pipe special sections not subject to the above requirements shall be tested by non-destructive testing methods in accordance with AWWA C200 Section 5.2.2.1. In the event the bell is formed subsequent to hydrostatic test, perform a magnetic particle examination two inches beyond either side of that portion of welded longitudinal joint which is within the longitudinal limits of the area of plate subjected to deformation in forming the bell; provided, that a minimum of 10 percent of the longitudinal welds described above shall be examined by the radiographic method.

3. After completion of the shop hydrostatic test, test each section of pipe with manholes and outlets attached as follows:
   a. Except as specifically shown on the plans (or except as specifically noted below), for \( d/D \) greater than 0.35, where \( d \) is the nominal diameter of the outlet and \( D \) is the nominal diameter of the main pipeline, test each section by the hydrostatic test method plus soap and compressed air method at the collar. Pipe special sections not subject to the above requirements shall be tested by non-destructive testing methods in accordance with AWWA C200 Section 5.2.2.1.
   b. For \( d/D \) less than 0.35, test the collar by the soap and compressed air method.

4. Perform tests of production welds in accordance with AWWA C200 for each heat of steel used. Perform impact tests on weldments in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, on each heat of steel used. Do not use runoff plates for weld test coupons. A guided-bend test specimen shall be considered as having passed only if no crack or other open defect exceeding 1/8 inch measured in any direction is present in the weld metal or heat affected zone of the base material after the bending. A tension test specimen shall be considered as having passed only if failure occurs in the base metal at a stress in excess of the minimum specified tensile strength. Report both yield and ultimate strength of each test specimen. Impact test values shall equal those required for the base materials. There shall be at least one impact test and one set of welding tests as described in AWWA C200, for each 1,000 lineal feet of spiral seam weld in addition to tests specified in Section 3.3.6 of the same standard.

5. Test each slip-on type flange by the soap and compressed air method.

6. Test backgouge and completed weld of all manual process groove welds by the liquid penetrant method. Test completed fillet welds by the liquid penetrant method.

B. Test Methods

1. Shop Hydrostatic Test: Vent air from the pipe before the test pressure is applied. Hold the test pressure on each section for a sufficient length of time to permit inspection of all joints. Use the following hydrostatic test pressures for testing pipes without outlets:
$$P = \frac{1.6 \times f_y \times T}{D}$$

Where:

- $P$ = test pressure in psi.
- $f_y$ = yield stress of the steel used, in psi.
- $T$ = minimum thickness of the steel pipe section tested in inches.
- $D$ = internal diameter of the steel pipe or cylinder, in inches.

2. The hydrostatic test pressure for fabricated bends and pipes with outlets shall be in accordance with AWWA M-11.

3. When subjected to the above hydrostatic test pressure, the pipe shall show no leaks, distortion, or other defects. Repair any leaks or other defects which develop during the hydrostatic test by chipping out and rewelding, after which the repaired section shall again be tested until it shows no leaks or other defects.

4. Test Bulkheads: Furnish and attach suitable dished heads and blind flanges for making the hydrostatic tests, and after completion of the tests, remove the heads and properly restore the ends of the sections.

5. Radiographic Test: Make the radiographs in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, Pressure Vessels. Repair defects in the welds disclosed by the radiographs. Submit all radiographs and the notation of areas for repair to the Engineer for review.

6. Ultrasonic Test: Make the ultrasonic tests in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, Pressure Vessels. Repair defects in the welds disclosed by ultrasonic testing. Prepare a report of the ultrasonic testing and submit to the Engineer for review.

7. Soap and Compressed Air Test: Use compressed air at maximum 40 psi pressure into the joint, and while the joint is under pressure, swab every portion of every welded seam forming a part of the joint with a heavy soap solution or a commercial bubble-producing leak test fluid. Examine for leakage. Repair any defects disclosed by the test by chipping out, rewelding the chipped section, and retesting. Drill and tap the necessary test holes, and plug weld the holes after testing.

8. Liquid Penetrant Test: Conform to the requirements in ASTM E165. Provide materials either water washable or nonflammable. Products: "Spotcheck" by the Magnaflux Corporation or "Met-L-Check Flaw-Findr" by the Met-L-Check Company. Chip out all defects, reweld, and retest the section affected until it shows no leaks or other defects.

9. Magnetic Particle Test: Conform to the requirements in ASTM E709, using the dry powder technique. Chip out defects, reweld, and retest the section affected until it shows no leaks or other defects.

3.05 CURVES, ANGLES, CLOSURES, AND SHORT SECTIONS

A. Furnish closing courses and short sections of pipe to ensure the correct location of outlets, angles, and other pipeline features and to accommodate the pipeline installation, lining, and field testing programs. Closing courses and short sections of steel pipe shall be not less than four feet in length. Accurately form the inside diameter of butt-straps to match the largest outside diameter of the adjacent steel cylinders to which they are to join.

B. The angular deflection at any field joint in square-ended pipe shall not exceed a pull of 3/4-inch, and the penetration of the spigot into the bell at all points of the circumference shall be at least equal to the required penetration shown on the Plans. Do not use angular deflections at butt-strap joints.

C. Use pipe sections having beveled bell ends for curves and angles in the alignment which cannot be accomplished using the maximum allowable deflection at square-ended pipe joints. Beveled pipe sections
used in curved alignment shall be of standard length except when shorter sections are required to limit the radius of curvature in which case all sections shall be of equal length. Do not bevel spigot ends. The beveled end of a pipe shall not have a deflection from a plane perpendicular to the pipe axis exceeding 3.0 degrees.

D. Fabricated Bends

1. Do not use fabricated bends to accomplish angles in the alignment unless shown on the Plans or permitted by the Engineer. Deflection between the centerline of adjacent courses shall not exceed 15 degrees. Double-butt weld girth seams in the shop.

2. The radius of curvature (R) for the axis of fabricated bends shall be 2.5 times the inside pipe diameter (D). The design shown on the Plans is based on such radius. However, a radius of curvature smaller than 2.5 times the inside pipe diameter can be used provided the following hoop stress intensification factor (SI) is used to determine wall thickness. Allowable hoop stress shall be 0.6 times the yield stress of the steel.

\[
SI = \frac{R-0.167D}{R-0.5D}
\]

3.06 MANHOLES, OUTLETS, AND PASS HOLES

A. Install manholes and outlets vertically unless otherwise shown on the Plans. Install at the stations shown for street-type installations, and install closures where required to conform to the designated locations. The manhole stations for right of way installations may be shifted a maximum of six feet with written approval of the Engineer, provided that the outlet is no closer than eight feet to the end of the pipe section.

B. The Contractor may provide, at his own expense, additional flanged outlets in the steel pipe for use in passing hose, lead wires, equipment, or materials into the pipe.

C. The Contractor may also provide, at his own expense, forged steel threaded outlets for use in passing hose or lead wires into the pipe. Tap the outlets for standard pipe thread, weld to the pipe, and close after use with solid forged steel plugs. The plugs shall not project beyond the inner surface of the pipe shell. Retap the pipe thread in the outlet to correct any distortion caused by welding. Apply a seal weld made by at least two passes around the inside or outside of the plug after it has been inserted in final position in the field.

D. Coat outlets, plugs, and closures inside and outside to match the adjacent coated surfaces in the same manner as specified for outlets and as required at field joints in the pipe.

3.07 PIPELINE LININGS AND COATINGS

A. Apply cement mortar lining to welded steel pipe, pipe fittings and specials except where the limits of epoxy or polyurethane lined pipe is shown on the Plans. Apply pipeline coatings to welded steel pipe, pipe fittings and specials according to the limits for the type of coating system as shown on the Plans, or as specified herein. Apply pipeline linings and coatings in accordance with the specifications for the type of lining and coating indicated.

B. Coat the interior metal surfaces of the blind and reducing flanges of manholes and outlets with System No. 7 per Section 09900, Painting and Coating.

C. Coat the exposed pipe ends at insulating joints and other couplings with solid epoxy. Do not coat over insulating gasket.

D. Coat exposed pipe in vaults and structures in accordance with Section 09900, Painting and Coating, System No. 10 or System No. 11.
3.08 BLIND FLANGES

A. At outlets not indicated to be connected to valves or to other pipes, provide blind flanges with bolts, nuts, and gaskets. Provide blind flange thickness at least equal to thickness of mating flange or in accordance with AWWA C207, whichever is greater.

3.09 PRODUCT MARKING

A. Prior to shipment, plainly and permanently mark the inside of each length of straight pipe at the bell end and each pipe special and fitting to identify the design pressure or head, the steel wall thickness, the date of manufacture, the mark number, the field top designating position of the pipe by reference to the layout schedule and the designation "Bell End". For beveled pipe, show the degree of bevel and field top. Show the mark number in four inch tall letters at springline of pipe.

B. Mark on the inside of the pipe a continuous, circumferential line, 1/16 inch wide, 12 inches from the end of each bell section. For plant cement mortar lined pipe, place the mark on the lining. The circumferential line will be used to evaluate fit up during installation.

C. Mark a continuous line, two inches wide, along the outside of each pipe section at the point on the circumference to laid uppermost (field top). Along this line, three feet from each end of the pipe section, permanently mark the pipe number in four-inch tall letters.

D. Punch mark the spigot end of pipe sections at the field top.

3.10 PIPE BRACING

A. Adequate pipe bracing shall be provided on all specials, fittings, and straight pipe so as to avoid damage to the pipe and fittings during handling, storage, and hauling. The following requirements shall apply:

1. The pipe bracing shall be placed as soon as practical and shall remain in place while the pipe is loaded, transported, and unloaded at the jobsite. If shop application of the cement mortar lining is selected, bracing shall be installed as soon as practical after the application of the cement mortar lining.

2. Piping shall be transported with vertical and horizontal bracing per manufacturer's plan. Any pipe damaged during handling, hauling, or storage due to improper bracing shall be repaired or replaced.

3. Pipe bracing may be reused, provided all damaged ends are redressed to provide square and uniform bearing and all previously used fasteners are removed.
PART 1 - GENERAL

1.01 DESCRIPTION
   A. This section includes installation and placement of pipelines and pipe bedding, pipeline closures, welding and welded connections, lining and coating at joints, and encasement.

1.02 RELATED WORK SPECIFIED ELSEWHERE
   A. Section 02140 Dewatering
   B. Section 02200 Earthwork
   C. Section 02310 Tunneling
   D. Section 02653 Steel Pipe
   E. Section 02676 Pressure Testing of Piping
   F. Section 09871 Cement Mortar Coating
   G. Section 09872 Coal-Tar Coating
   H. Section 09873 Cold-Applied Plastic Tape Coating
   I. Section 09874 Fusion-Bonded Epoxy Lining and Coating
   J. Section 09875 Field-Applied Cement Mortar Lining
   K. Section 09900 Painting and Coating
   L. Section 15000 Piping Schedule and General Piping Requirements

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS
   A. American Society for Testing and Materials
      C33 Specification for Concrete Aggregates.
      C150 Specification for Portland Cement.
   B. American Water Works Association
      C205 Cement Mortar Protective Lining and Coating for Steel Water Pipe.
      C206 Field Welding of Steel Water Pipe.
   C. American Welding Society
      D1.1 Structural Welding Code.
   D. American Society of Mechanical Engineers Boiler and Pressure Vessel Code Sec. IX.
1.04 SUBMITTALS

A. Installation schedule.

B. Installation methods for pipes to be installed in tunnels and casings.

C. Weld procedure specification, procedure qualification records including all destructive and non-destructive test results and welding bead profiles as required along with individual welder qualification certificates. The Engineer shall be present during qualification of weld procedure. No welding shall begin until welding procedures and welder certifications have been approved in writing by the Engineer. Procedures for multi-pass groove or fillet welds shall show clearly the number of passes, conforming to the limits shown in 3.08 B.

D. Written certification that each pipe joint, butt strap and other appurtenances and each field weld is in accordance with these specifications. Provide certification of compliance for each field weld.

E. Material certificates of field welding electrodes and welding electrode field handling procedures. Storage of low-hydrogen Shielded Metal Arc Weld electrodes shall be in accordance with AWS D1.1 Section 5.3. Storage of Flux Cored Arc Weld - Gas Shield electrodes shall minimize moisture pickup and corrosion. Do not begin welding until these procedures have been approved in writing by the Engineer.

F. Material certificates for bolts, nuts, washers and bolt torque recommendations.

G. Pipe handling methods and equipment used to handle pipe from delivery at the site to placement in the trench. Show spreader bar dimensions.

H. Stilling Plan. Include with the stilling submittal a description of any alternate materials (i.e., steel stulls and bracing) for stulling and bracing of the pipeline for shipping and installation. Submit details, including verifying calculations, of alternate materials showing size of each member, number required, and anchoring method. Any welding required to anchor alternate stull materials shall be ground smooth prior to application of field lining.

I. Pipe elongation plan and dimensions.

J. Affidavit of compliance with standards referenced herein. All tests of material referenced shall be executed prior to fabrication and installation. Submit certified results with affidavits of compliance.

K. Procedure to prevent loss of shielding gas for FCAW-G method.

PART 2 - MATERIALS

2.01 CEMENT MORTAR FOR INSIDE JOINTS

A. Cement mortar for lining inside joints shall be composed of not less than one part cement to two parts sand by weight, dry mixed and moistened with sufficient water to permit packing and troweling without crumbling. Cement shall be type II, low alkali, conforming to ASTM C150. Water shall be clean and free of organic matter, alkali, salts and other impurities which might reduce the strength, durability, or other quality of the cement mortar.

2.02 CEMENT MORTAR COATINGS

A. Materials for cement mortar coating of the exterior joints shall be in accordance with AWWA C205, and as follows. Sand shall conform to ASTM C33. Water shall be clean and free of objectionable quantities of organic matter, alkali, salts and other impurities which might reduce the strength, durability, or other quality of the cement mortar. Cement mortar coating shall consist of not more than 4-1/2 cubic feet of sand to one sack of cement (94 pounds).
2.03 CONCRETE
   A. Concrete for pipe or encasement, thrust blocks and cutoff walls shall be Class A concrete in accordance with Section 03000, General Concrete Construction, unless otherwise shown on the Plans.
   B. Lean concrete backfill shall be Class C per Section 03000, General Concrete Construction.

2.04 STULLS AND BRACING
   A. Stulls and bracing shall be cut from kiln-dried timbers. Minimum size of stulls shall be shown on the Plans.

2.05 GROUT BANDS
   A. Grout bands or diapers shall be polyethylene foam-lined fabric with steel strapping of sufficient strength to hold the fresh mortar, resist rodding of the mortar and allow excess water to escape. The foam plastic shall be 100 percent closed cell, chemically inert, insoluble in water and resistant to acids, alkalies and solvents.

PART 3 - EXECUTION

3.01 EXISTING CONDITIONS
   A. Location, invert elevations, materials of construction, joint type and geometry, slope and dimensions of existing pipelines and concrete encasements shown on the Plans are approximate. Where crossing or connecting to existing pipelines, and at other locations shown on the Plans or as directed by the Engineer, excavate and verify actual location, depth of pipeline or encasement, pipe slope, joint type, joint geometry, and angle of joint prior to submittal of shop drawings for fabrication of pipe.
   B. Plan joint completion to accommodate: temporary test bulkheads for hydrostatic testing; in-place cement mortar lining; and traffic control plan sequencing.

3.02 DELIVERY AND TEMPORARY STORAGE OF PIPE AT SITE
   A. For plant cement mortar lined pipe, keep plastic caps placed over the ends of each pipe until immediately prior to placing the pipe in the trench installation. Add water to interior of pipe if plastic cap is temporarily removed and replaced or repaired. Repair immediately damaged plastic caps. Maintain complete bracing per Manufacturer's recommendation inside of each section of pipe until the installation of stulling.
   B. Transport pipe to the jobsite on padded contoured bunks with nylon tie-down straps to protect the pipe. Each pipe shall be supported on a minimum of two contoured bunks.
   C. Coordinate the spacing of earth berms at the recommendation of the pipe manufacturer.

3.03 HANDLING OF PIPE
   A. Coordinate methods of handling and rigging at the recommendation of the pipe manufacturer, but no less stringent than required herein. Handle the pipe using two 12 inch minimum width belt slings attached to a spreader bar. Do not use cable slings or chains. Avoid damage to lining and coating.
   B. Measure the outside diameter of bell and spigot to check that clearance between faying surfaces is within specified tolerance prior to joint assembly. Confirm that pipeline markings have been applied in accordance with Section 02653, Steel Pipe.
   C. Maintain at least one brace at each end of each steel pipe to be lined in the field. Provide additional vertical stulls before backfilling welded steel pipe.
   D. Repair or replace, as directed by the Engineer, pipe damaged as a result of transporting or handling.
3.04 SANITATION OF PIPE INTERIOR
A. During laying operations, do not store tools, clothing, or other materials in the pipe. Keep the pipeline free of construction debris, dirt, and other loose materials. Where necessary, utilize bulkheads or other methods to prevent entry of storm water runoff into pipeline.
B. When pipelaying is not in progress, including the noon hour, close the ends of the pipe with vermin- and child-proof plugs.

3.05 PLACEMENT OF PIPE IN TRENCH
A. Control water in trench per Section 02140, Dewatering.
B. Cut a 12 inch minimum depth depression to accommodate exterior welding, tape wrapping, flange assembly, cement mortar coating and any testing at pipe joints, and provide space to permit removal of the pipe handling slings.
C. Complete pipe bedding and/or stabilization of foundation per Section 02200, Earthwork. Place and compact material specified for the pipe bedding to bring the trench bottom to grade.
D. Inspect each pipe and fitting before lowering into the trench. Inspect the interior and exterior protective coating, and repair damaged areas. Clean ends of pipe thoroughly. Remove foreign matter and dirt from inside of pipe and keep clean during and after laying.
E. Prior to installing pipe 48 inch and larger in trench, install stulling of proper length to elongate the vertical diameter of welded steel pipe as shown on the Plans. Do not elongate pipe that will be concrete encased. Place vertical and horizontal stulls in encased pipe to the nominal diameter with a tolerance of plus 1/4 inch or minus 1/4 inch.
F. Lay pipes uphill on grades exceeding 10 percent.
G. Lay each section of pipe in the order and position shown on the approved pipe laying schedule. Lower the pipe onto the pipe bedding and install it to line and grade. For bell and spigot joints, tolerance on grade is 1/4 inch, and tolerance on line is one inch. For butt-welded joints, tolerances on line and grade shall be 1/4 inch or as necessary to prevent the circumferential face of adjoining pipe sections to deviate not less than 1/8 inch or more than 1/4 inch at any point.
H. When installing beveled pipe, do not deviate the pipe field top mark by more than two inches from a vertical line passing through the pipe center.
I. Weld seams at adjacent pipes are to be staggered as shown on the plans.
J. Do not use dogs, clips, lugs, or other devices welded to the pipe to force it into place.

3.06 INSTALLING FLANGED OR EXPOSED PIPING
A. Inspect gasket seating surfaces, gasket, each stud or bolt, each nut, each washer, and the facing on which the nuts will rotate. Replace any damaged item.
B. Where a raised face flange connects to a flat-faced flange, provide a ring gasket filler between the two flanges. The ring gasket filler shall be of the same material as specified for the gasket between the flanges.
C. Set pipe with the flange bolt holes straddling the pipe horizontal and vertical centerline. Install pipe without springing, forcing, or stressing the pipe or any adjacent connecting valves or equipment.
D. Clean flanges by wire brushing before installing flanged fittings. Clean flange bolts and nuts by wire brushing, lubricate bolts with appropriate compound, and tighten in the sequence and to the torque as recommended by the Manufacturer. Replace galled, cracked, or distorted bolts and nuts. If flanges leak
under pressure testing, remove the nuts and bolts, reset or replace the gasket, install new bolts and nuts, and retest the joints. Joints shall be watertight. Do not reuse bolts, nuts or gaskets.

E. Patch or repair all scratches and damaged areas incurred while installing pipe.

F. Coat buried flanges per Section 09900, Painting and Coating, System No. 21 and System No. 24.

G. Where a flanged pipe penetrates a wall or slab, provide a minimum distance of 15 inches from the wall or slab to face of flange.

3.07 INSTALLING GROOVED AND SHOULDEROED PIPE AND FITTINGS

A. Install grooved shouldered pipe and fittings in accordance with the coupling Manufacturer's recommendations, and the following.

B. Clean loose scale, rust, oil, grease, and dirt from the pipe or fitting groove before installing coupling. Apply the coupling Manufacturer's gasket lubricant to the gasket exterior including lips, pipe ends, and housing interiors.

C. Fasten coupling alternately and evenly until coupling halves are seated. Apply torques as recommended by the coupling Manufacturer.

3.08 FIELD WELDED JOINTS

A. Provide single-welded lap joints, double-welded lap joints, butt-welded joints, and butt-strap joints as detailed on the Plans. The minimum overlap of the assembled bell and spigot sections of lap joints shall be as shown on the Plans.

B. Field welding shall be in accordance with AWWA C206 and AWS D1.1, except as modified herein. Any welder performing work shall have been qualified for the process involved within the past three years. SMAW welders shall be qualified in accordance with AWS D1.1, Table 4.9 and Figure 4.21. FCAW-G welding procedures and welders shall be qualified in accordance with ASME BPVC Sec. IX-92, QW 302.1 and QW 452.1 or 452.2, as applicable. Pre-qualified welding procedures shall not be accepted. No radiographic examination of test plates shall be accepted. A copy of the approved welding procedure specification followed by a welder during his/her qualification test shall be included with his/her test results. If the WPS document is different than that referenced on the welder’s test results, include a stamped certification by an AWS Senior CWI, CWI or an ICBO Registered Special Inspector/Structural Steel and Welding stating that the welder’s test fell within the essential variable limits of the submitted WPS. Procedures for multi-pass groove or fillet welds shall clearly show the number of passes, conforming to the limits shown below. Procedures and welder qualifications for plate 3/8 inch or thicker shall include Charpy V-notch test results per Specification Section 02653, Part 2.02, Paragraph C.

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<tr>
<td>SMAW</td>
<td>5/32 inch</td>
<td>2.5 X Elec. Diam.</td>
<td>1/8 inch</td>
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<tr>
<td>FCAW-G</td>
<td>5/64 inch</td>
<td>1/2 inch</td>
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C. All tack welds used for the installation of steel pipe shall be root passes in accordance with Paragraph J herein for electrode type, weld bead diameter and weld bead thickness. All tack welds shall be removed before the start of welding, or at the discretion of the Engineer, cleaned, prepared, and allowed to remain in place as a continuation of the root pass.

D. If joint faying surfaces are rusted or pitted where weld metal is to be deposited, clean them by wire brushing or sand blasting.
E. Complete the butt-welded longitudinal seams of butt-strap before starting circumferential fillet welds. Install backing bar per Plans to facilitate air testing. Backing bars shall be left in place.

F. Completed fillet welds minimum leg length shall be the sum of the least abutting plate thickness plus joint clearance. Prior to welding, remove all tack welds and equalize joint clearance around entire circumference. Inside tack welds made during fit-up may be left in place, prior to placing the root pass, provided they are sound, and of the same size and electrode as the subsequent root pass. All joint fit-up shall be done in the presence of the Engineer and the Engineer shall approve fit-up before starting the root pass. Complete the interior weld and receive the Engineer’s approval prior to welding the outside weld on any single joint.

G. Provide expansion lap joints at intervals of approximately 500 feet. Set the expansion section by stabbing the joint four inches, plus one inch, minus zero inch. Weld all joints either side of the expansion lap joints. Complete backfill of pipe except at the expansion lap joint. Begin welding of expansion lap joint during the coolest hour of the workday. After completion of welding, backfill the expansion lap joint portion of the pipe within the pipe zone with a cement slurry in accordance with Section 02200, Earthwork.

H. Preheat the joints to be welded where required in accordance with Table 1 of AWWA C206.

I. Where weld metal is to be deposited, clean joints by wire brushing or sand blasting. Clean each layer of deposited weld metal prior to depositing the next layer of weld metal, including the final pass, by a power-driven wire brush.

J. Welding shall be done by either the SMAW or FCAW-G method. The SMAW method shall be used on all welds on the exterior side of the pipe joint. Either the SMAW or the FCAW-G method may be used on all welds on the interior side of the pipe joint, provided the air velocity in the vicinity of the weld shall not exceed five miles per hour for the contractor to use the FCAW-G method. SMAW shall be applied by means of continuous stringer beads, with a maximum electrode diameter of 5/32 inch regardless of welding position. For SMAW method, maximum bead width shall be 2 1/2 times the electrode diameter, and maximum bead thickness shall be 1/8 inch. The electrode used on the root pass shall be E-6010 run downhill. Electrodes used for the remaining passes shall be E-7018 run uphill. FCAW-G shall utilize an external shielding gas in accordance with AWS A5.20, Table 2, and the electrode and pipe manufacturer’s recommendations. FCAW-G will be applied by means of continuous stringer beads run uphill. The maximum electrode diameter for FCAW-G shall be 5/64 inch. No welding shall begin until fit-up has been approved in writing by the Engineer. Complete and clean each pass around the entire circumference of the pipe or along the seam of the pipe before commencing the next pass. Completed fillet welds shall be convex. Only one welder shall be allowed per weld at any given time. During welding, a welding foreman, certified as a welding inspector, shall be onsite at all times.

K. For butt welded joints, align pipe faces to the tolerances shown on the Plans. Upon completion of the interior weld, remove backing bar, except for pipe installed in tunnels. Upon removal of the backing bar, gouge out the exterior of the joint to sound metal. Secure a clean surface to deposit weld metal, and complete exterior weld passes as necessary to fuse smoothly the plate surfaces. Grind smooth the weld metal to match the profile of adjacent pipe surfaces. All completed butt welded joints, except for pipe installed in tunnels, shall be tested by the radiograph testing procedures per Section 02653, Steel Pipe. Use an approved independent testing company to perform all radiograph tests. Testing of welds shall be done in the presence of the Engineer.

L. During welding of exterior joints, protect the welded steel pipe coating by draping an 18 inch wide strip of heat-resistant material all around the circumference of the pipe on each side of the coating holdback to avoid damage to the coating by hot weld splatter. Do not use the coated part of the pipe for ground.

M. Test all single-welded lap joint by the liquid penetrant method and test all butt-strap joints and double-welded joints by the soap and compressed air test after steel is cool to the touch and before completing joint coating or lining. Perform liquid penetrant tests and compressed air tests in accordance with Section 02653, Steel Pipe. Only individuals qualified per AWS D1.1 for NDT Level I and working under the NDT Level II or individuals qualified for NDT Level II may perform nondestructive testing. Perform all soap and air tests/liquid penetrant tests in the presence of the Engineer. Maintain records of test performed and results of testing for each location.
3.09 PIPELINE CLOSURE ASSEMBLIES

A. Use pipeline closure assemblies to connect sections of pipeline laid from opposite directions and to adjust the field length of the pipeline to meet structures, other pipelines, and points established by design stations. Select either follower ring design or butt strap design. Install follower ring closures as recommended by the pipe Manufacturer. Do not use butt-straps exceeding 15 inches in width.

B. Center the shaped steel butt straps over the ends of the pipe sections they are to join as shown on the Plans. No angular deflections will be allowed at butt-strap joints.

C. Cement mortar line closure assemblies to a thickness at least equal to the adjoining pipe sections. Clean the steel with wire brushes and apply a cement and water wash coat prior to applying the cement mortar. Steel-trowel finish the interior mortar lining to match adjoining mortar lined pipe sections.

D. Field trimming of pipe shall be square and normal to the axis of the pipe only.

3.10 COMPLETION OF INSIDE MORTAR JOINTS

A. Backfill the trench before applying interior lining at field welded joints.

B. Working inside the pipe, remove foreign substances which adhere to the steel joint rings, clean them, and pack cement mortar into each joint. Before placing the joint mortar material against the surfaces of the lining, the surfaces shall be carefully cleaned, have all soap removed, and then be wetted to provide a good bond between the lining and the joint mortar. Finish the surface with a steel trowel to match the adjoining pipes.

C. Remove excess mortar and other construction debris from the pipe interior.

3.11 COMPLETION OF EXTERIOR PIPE JOINT

A. Coat the exterior of welded steel pipe joints in accordance with the applicable provisions of Section 09871, Cement Mortar Coating, Section 09872, Coal-Tar Coating, Section 09873, Cold-Applied Plastic Tape Coating, or Section 09874, Fusion-Bonded Epoxy Lining and Coating.

B. Apply cement mortar coating and reinforcement over the dielectric coating as shown on the Plans. Mortar at field joints shall overlap the shop applied mortar coating a distance of not less than five inches, and the thickness of the field mortar coating shall not be less than 1-1/4 inches. Allow the cement mortar coating to set for a minimum of 24 hours before commencing backfilling operations. The Engineer may order the diapers be removed for inspection prior to backfilling.

3.12 PIPE BACKFILL, STULLS AND BRACING

A. Trench backfill operations shall be in accordance with Section 02200, Earthwork.

B. Stulls placed in welded steel pipe shall remain in the pipe a minimum of two weeks after the backfill is completed, or as directed by the Engineer.

C. Do not remove the cross stulling in pipe to be encased until the encasement has cured at least seven days and the subsequent backfill is completed.

3.13 CONCRETE FOR BELOW-GROUND INSTALLATION

A. Encase pipe with concrete to the line and dimensions as indicated on the Plans or place concrete between the undisturbed ground and the pipe or fittings to be restrained or supported.

B. Provide thrust blocks at fittings in pipe having rubber gasket bell and spigot or unrestrained mechanical joints. Do not provide thrust blocks for steel pipe having welded, flanged, or butt strap joints unless detailed on the Plans or required in the detailed piping specification. Construct thrust blocks based on the test
pressures given in Section 02676, Pressure Testing of Piping. Size thrust blocks and provide bearing area against the undisturbed ground in accordance with the SDARSD for thrust block sizes, or as shown on the Plans.

C. Provide temporary support for pipe, fittings, or valves until the concrete has obtained a two-day cure. Place concrete such that the pipe joints, fittings, or valves are accessible for repairs and removal and replacement.

D. Do not backfill the trench adjacent to concrete until the hydration process has produced a concrete that is hard enough to be self-supporting but not less than 48 hours after the last pour. Allow concrete to cure to 75 percent of 28-day compressive strength, and for at least seven days, prior to subjecting the concrete to pipeline pressure.

3.14 CONCRETE CUTOFF WALLS

A. Construct concrete cut-off walls on slopes exceeding 30 percent (16.7 degrees) at maximum 100-foot intervals, unless otherwise shown on the Plans.

3.15 PLACEMENT OF PIPE IN ENCASEMENTS, TUNNELS AND CASINGS

A. Do not injure pipe by dragging or sliding on concrete, asphalt or ground. Use pipeline casing insulators or dollies to move pipe through casing.

B. Block each section of pipe to prevent uplift and to ensure required line and grade. Maintain minimum annular space between pipe and tunnel excavation as shown on the Plans. Remove all obstructions between pipe and tunnel floor to permit concrete backfill to fill all spaces. Do not allow contact between exposed metal of pipe and metal casing, struts, or liner plates. All pipe supports and blocking shall be constructed using concrete cradle supports. Pipe supports and blocking shall be constructed to support the weight of each pipe section to be installed. A minimum of two pipe cradles will be required for each pipe.

C. Weld the pipe joints in accordance with the details shown on the Plans.

D. Maintain horizontal and vertical stulling during placement of concrete backfill.

3.16 PIPE DEFLECTION

A. Upon completion of backfill and the removal of all stulling, the maximum acceptable deflection of the pipe shall be 1 percent from the nominal diameter. The percent deflection shall be calculated by the following formula:

\[
\text{Percent deflection} = \frac{(\text{nominal diameter-actual diameter})}{\text{nominal diameter}} \times 100
\]

B. Should the deflection exceed the acceptable deflection stated above, excavate the backfill material, repair all damaged lining and coating, reinstall stumping, recompact, and retest for pipe deflection until acceptable deflection measurements are obtained.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes materials and procedures for disinfection of all treated and untreated water pipelines in accordance with AWWA C651, as modified below.

B. All chlorinated water discharge shall be dechlorinated per AWWA C651, current NPDES regulations, and state and local regulatory agency requirements to ensure compliance with all applicable rules and regulations.

1.02 RELATED WORK DESCRIBED ELSEWHERE

A. Section 02676 Pressure Testing of Piping

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Water Works Association
   B300 Standard for Hypochlorites
   B301 Standard for Liquid Chlorine
   C651 Disinfecting Water Mains

1.04 SUBMITTALS

A. Plan for disinfection method and procedure, including equipment used to inject the chlorine solution, gauges and/or scales to measure the rate at which chlorine is injected, qualifications of the personnel performing the disinfection, testing locations, testing schedule, source of potable water, and water disposal locations. Personnel performing the disinfection shall demonstrate a minimum of five years experience in the chlorination and dechlorination of large diameter pipelines.

B. Qualifications of certified testing laboratory.

C. Six copies of bacteriological test results to the Engineer upon completion of each test.

D. Approvals of local agencies regulating chlorination facilities.

E. Emergency Response Plan/Transportation Plan.

F. Prior to the discharge of water used in the disinfection process, submit a plan which describes the proposed method of dechlorination, including equipment used to measure the introduction of chemicals to neutralize the chlorine, the concentration of neutralizing solution, the discharge flow rate, testing methods, and a discharge schedule.

G. Provide a daily record of the average flow rates and chlorine residual, as measured at the sample points for all discharge water and receiving waters from draining and flushing the pipeline.

1.05 JOB CONDITIONS

A. Discharge of chlorinated water into watercourses or surface waters is regulated by the California Regional Water Quality Control Board, San Diego Region, under the National Pollutant Discharge Elimination System. Schedule and coordinate rates of flow and locations of discharge of disinfection and flushing water with the Engineer and cognizant state and local regulatory agencies to ensure compliance with all applicable rules and regulations.
B. Use potable water for chlorination.

C. Submit request for use of water from waterlines of owner two working days in advance.

D. Disinfection operations shall be scheduled by the Contractor such that acceptable chlorine residual and bacteriological test results will be submitted no earlier than seven days prior to the date of acceptance of the completed work as defined in Section 7.9 of the General Conditions (or within seven days of the right to occupy the completed portions of the work as defined in Section 7.8 of the General Conditions). Should test results be provided to the Engineer more than seven days prior to acceptance of the work, the pipelines shall be retested as required herein, and any failing tests will require the Contractor to repeat the chlorination and testing until satisfactory results are obtained.

PART 2 - MATERIALS

2.01 FORM OF CHLORINE

A. Use calcium hypochlorite, sodium hypochlorite, or liquid chlorine conforming to AWWA B300 and B301. Calcium hypochlorite tablets shall not be used for disinfecting pipes larger than 24 inches in diameter.

2.02 CHLORINE RESIDUAL TEST KIT

A. For measuring chlorine concentration, supply and use a medium range, drop count, titration kit or an orthotolidine indicator comparator with wide range color discs. Range to match chlorine concentration limits. Products: Hach Chemical, or equal. Maintain kits in good working order available for immediate test of residuals at point of sampling.

PART 3 - EXECUTION

3.01 CONTINUOUS FEED METHOD FOR PIPELINES

A. Introduce potable water into the pipeline at a constant measured rate. Feed the chlorine solution into the same water at a measured rate. Proportion the two rates so that the chlorine concentration in the pipeline is maintained at a maximum concentration of 30 mg/l. Check the concentration at points downstream during the filling to ascertain that sufficient chlorine is being added.

3.02 SLUG METHOD FOR PIPELINES

A. The pipe section to be tested shall be full prior to the introduction of the chlorine solution. Introduce water in the test section at a constant measured rate. At the start of the test, feed the chlorine solution into the pipeline at a measured rate so that the chlorine concentration created in the pipeline is not less than 100 mg/l. Feed the chlorine for a sufficient period to develop a solid column or "slug" of chlorinated water that will, as it passes along the line, expose all interior surfaces to a concentration of 100 mg/l for three hours. If at any time the concentration drops to below 50 mg/l, discontinue the flow; move the chlorination equipment to the head of the slug; and as flow is resumed, apply chlorine to restore the concentration to not less than 100 mg/l.

3.03 DISINFECTION OF VALVES AND APPURTENANCES

A. During the period that the chlorine solution or slug is in the section of pipeline, open and close valves to obtain a chlorine residual at pipeline appurtenances.

3.04 CONFIRMATION OF RESIDUAL

A. After the chlorine solution applied by the continuous feed method has been retained in the pipeline for 24 hours, confirm that a chlorine residual of not less than ten mg/l exists along the pipeline by sampling at air valves and other points of access. With the slug method, confirm by sampling as the slug passes each access point and as it leaves the pipeline.
3.05 REPETITION OF PROCEDURE

A. If the initial chlorination fails to produce the required residuals and bacteriologic test results, repeat the chlorination and retesting until satisfactory results are obtained. Any water used for retesting shall be obtained at the Contractor's expense.

3.06 PIPELINE FLUSHING

A. After confirming the chlorine residual, flush the excess chlorine solution from the pipeline, or drain the pipeline and fill with new water, until the total chlorine concentration in the water leaving the pipe is within 0.5 mg/l of the replacement water.

B. Prior to the discharge of water to receiving surface waters, the water shall be dechlorinated to obtain an instantaneous maximum chlorine residual of 0.02 mg/l. The discharge of water shall not cause surface erosion or scouring.

3.07 BACTERIOLOGIC TESTS

A. After final flushing and before connection to a distribution system, two consecutive sets of acceptable samples shall be taken at least 24 hours apart. All sampling and testing shall be done by a certified laboratory which has been approved by the Engineer. At least one set of samples shall be collected from all ends including branches and every 2000 feet of the pipeline or as directed by the Engineer.

B. Test all samples for bacteriological quality in accordance with Standard Methods for the Examination of Water and Wastewater, and shall show the absence of coliform organisms.

3.08 TEST FACILITY REMOVAL

A. After satisfactory disinfection, replace air valves, restore the pipe coating, and complete the pipeline where temporary disinfection or test facilities were installed.

3.09 CONNECTIONS TO EXISTING PIPELINES

A. To prevent contamination of the new or existing pipeline, disinfect pipeline closure sections, fittings, valves, and other appurtenances used to perform the permanent connections to an existing water system by swabbing the interior of all surfaces with a 1 percent solution of chlorine just prior to installation.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section specifies the hydrostatic and leakage testing of pressure piping in water distribution and transmission mains.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02200 Earthwork
B. Section 02310 Tunneling
C. Section 02675 Disinfection of Piping
D. Section 15058 PVC Pipe and Fittings, Three Inches and Smaller
E. Section 15100 Valves
F. Section 15122 Pipe Couplings and Expansion Joints

1.03 SUBMITTALS

A. Pressure test bulkhead locations and design calculations, water supply details including backflow preventers, flow meters, valves and drains.

B. Six copies of the test records to the Engineer upon completion of the testing.

C. Provide a recent record of pressure gauge calibrations.

D. Provide records of each pipe section during testing. Test records shall include:
   1. Date of test.
   2. Identification of pipeline, or pipeline section, tested or retested.
   3. Identification of pipeline material.
   4. Identification of pipe specification.
   5. Test fluid.
   6. Test pressure.
   7. Remarks: Leaks identified (type and location), types of repairs, or corrections made.
   8. Certification by Contractor that the leakage rate measured conformed to the specifications.
   9. Test duration.
   10. Allowable losses.
   11. Actual losses.

E. Submit locations for disposal of testing water.
PART 2 - MATERIALS

2.01 VENTS AND DRAINS FOR ABOVE-GROUND PIPING
A. Install vents on the high points of above ground piping, whether shown on the Plans or not. Install drains on low points of above ground piping, whether shown on the Plans or not. Provide a valve at each vent or drain point. Valves shall be 3/4 inch for piping three inches and larger and 1/2 inch for piping smaller than three inches. Valves shall be as specified in Section 15100, Valves, unless otherwise shown on the Plans.

2.02 MANUAL AIR-RELEASE VALVES FOR BURIED PIPING
A. Where necessary, provide temporary manual air-release valves for pipeline test. Construct the pipe outlet in the same manner as for a permanent air valve and after use, seal with a blind flange, pipe cap, or plug and coat equal to the adjacent pipe.

2.03 TEST BULKHEADS
A. Design and fabricate test bulkheads per Section VIII of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code. Materials shall comply with Part UCS of said code. Design pressure shall be at least 2.0 times the specified test pressure for the section of pipe containing the bulkhead. Limit stresses to 70 percent of yield strength of the bulkhead material at the bulkhead design pressure. Include air-release and water drainage connections.

2.04 TESTING FLUID
A. For potable water pipelines, obtain and use only potable water for hydrostatic testing.
B. Meet all applicable state and local requirements for disposal of testing water and obtain all required permits.

2.05 TESTING EQUIPMENT
A. Provide calibrated, six-inch diameter face pressure gauges and a chart recorder, pipes, bulkheads, pumps, and calibrated meters to perform the hydrostatic testing. Use laboratory calibrated test gauges and meters, which shall be calibrated by a certified laboratory prior to the test.

PART 3 - EXECUTION

3.01 TESTING PREPARATION
A. Install AWWA approved reduced pressure-principle backflow preventers and turbine flow meters at each water supply connection. When test water is supplied by an Agency other than the Water Authority, the Contractor must comply with the requirements of the water provider.
B. Conduct pressure tests on exposed and above ground piping after the piping has been installed and attached to the pipe supports, hangers, anchors, expansion joints, valves, and meters. All pressure pipelines shall be tested, including piping and valves inside of structures. No pressure test is required for vent overflow and buried blowoff piping.
C. Conduct pressure tests on buried piping after the trench has been completely backfilled.
D. Provide any temporary piping needed to carry the test fluid to the piping that is to be tested. After the test has been completed and demonstrated to comply with the specifications, disconnect and remove temporary piping.
E. Provide temporary drain lines needed to carry testing fluid away from the pipe being tested. Remove such temporary drain lines after completing the pressure testing.
3.02 CLEANING

A. In pipelines less than 24 inches in diameter, before conducting hydrostatic tests, flush pipes with water to remove dirt and debris. Maintain a flushing velocity of at least three fps. Flush pipes for the minimum time period as given by the formula below and as required to thoroughly clear the pipeline of dirt and debris.

\[ T = \frac{2L}{3} \]

Where:  
T = flushing time (seconds)  
L = pipe length (feet)

B. In pipes 24 inches or larger in diameter, clean the pipe using high-pressure water jet, sweeping, scrubbing, or equally effective means. All water, sediment, dirt, and foreign material accumulated during this cleaning operation shall be discharged, vacuumed, or otherwise removed from the pipe.

3.03 TESTING AND DISINFECTION SEQUENCE

A. Perform required chlorination after the completion of hydrostatic testing per Section 02675, Disinfection of Pipelines.

3.04 INITIAL PIPELINE FILLING FOR HYDROSTATIC TESTING

A. Control maximum rate of filling to prevent water velocity in pipeline from exceeding one fps. Filling may be facilitated by removing and replacing automatic air valves and releasing air manually.

3.05 HYDROSTATIC TESTING OF ABOVE GROUND OR EXPOSED PIPING

A. Open vents at high points of the piping system to purge air while the pipe is being filled with water. Subject the piping system to the test pressure specified herein. Maintain the test pressure for a minimum of 24 hours. Examine joints, fittings, valves, and connections for leaks. The piping system shall show zero leakage or weeping. Repair leaks and retest until zero leakage is obtained. Air and vacuum valves shall be in place and operational in case of pipe failure during testing.

3.06 HYDROSTATIC TESTING OF BURIED PIPING

A. Where any section of the piping contains concrete thrust blocks or encasement, do not pressure test until at least 10 days after the concrete has been poured. When testing cement mortar lined piping, fill the pipe to be tested with water and allow it to soak for at least 48 hours to absorb water before conducting the pressure test.

B. Apply and maintain the test pressure by means of a hydraulic force pump.

C. Maintain the test pressure for the following duration by restoring it whenever it falls an amount of five psi:

<table>
<thead>
<tr>
<th>Pipe Diameter (inches)</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 and less</td>
<td>4</td>
</tr>
<tr>
<td>20 to 36</td>
<td>8</td>
</tr>
<tr>
<td>Greater than 36</td>
<td>24</td>
</tr>
</tbody>
</table>

D. After the test pressure is reached, use a meter to measure the additional water added to maintain the pressure. This amount of water is the loss due to leakage in the piping system. The allowable leakage rate is defined by the formula:

\[ L = HND(P)^{1/2} \]
Where:  
H = specified test period (hours)  
L = allowable leakage (gallons)  
N = number of rubber-gasketed joints in the pipe tested  
D = diameter of the pipe (inches)  
P = specified test pressure (psig)  
C = 7,400

E. The allowable leakage for welded steel pipe shall be zero gallons.

F. The allowable leakage for buried piping having threaded, brazed, or welded (including solvent welded) joints shall be zero gallons.

G. Repair and retest any pipes showing leakage rates greater than that allowed in the above criteria.

3.07 TEST PRESSURE

A. A test pressure (in psi) corresponding to a hydrostatic head achieved at gauge location shall be derived from the following formula. The Test HGL and Pipeline Invert Elevation shall be indicated on the Plans.

\[
\text{Test Pressure} = \frac{\text{Test HGL} - \text{Pipeline Invert Elevation}}{2.31}
\]

3.08 REPETITION OF TEST

A. If the actual leakage exceeds the allowable, locate and correct the faulty work and repeat the test at the Contractor's expense. Restore the work and all damage resulting from the leak and its repair. Eliminate visible leakage.

3.09 BULKHEAD AND TEST FACILITY REMOVAL

A. After a satisfactory test, remove test bulkheads and other test facilities, restore the pipe lining and coatings, and fill the pipeline section tested with water and maintain it full until disinfection of pipeline at the completion of the contract. The Contractor shall assume all responsibility for any damage to the pipeline as a result of pressure imposed during the operations of filling the pipeline with water and conducting the tests.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes the supply and installation of permanent fencing and gates.

B. Provide all new materials except when use of salvaged materials is approved by the Engineer.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02110 Clearing and Grubbing

B. Section 02315 Portal Area Development

C. Section 02940 Revegetation

D. Section 03000 General Concrete Construction

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Society for Testing and Materials

   A53 Specification for Pipe, Steel, Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless.

   A121 Specification for Zinc-Coated (Galvanized) Steel Barbed Wire.

   A392 Specification for Zinc-Coated Steel Chain-Link Fence Fabric.

   A501 Specification for Hot-Form Welded and Seamless Carbon Steel Structural Tubing.

   A641 Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.

   F668 Specification for Poly (Vinyl Chloride) (PVC)-Coated Steel Chain-Link Fence Fabric.

   F669 Specification for Strength Requirements of Metal Posts and Rails for Industrial Chain Link Fence.

1.04 SUBMITTALS

A. Manufacturer's catalog data showing all fencing components and details of fencing, gates, extension arms, tension bands and bars, sleeves, ties and clips and color palette for PVC coating.

B. Certificates of Compliance from the manufacturer attesting that all materials meet the requirements specified herein.

C. A layout drawing showing spacing of post and location of gate, corner, end and pull post.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site with sufficient protection, bracing, etc., to ensure arrival in undamaged condition. Store materials in original bundles at the designated location, on level supports off the ground to provide protection against oxidation caused by ground contact.
PART 2 - MATERIALS

2.01 FENCING MATERIALS

A. Fencing Fabric. Conform to ASTM A392, six feet high, size nine wire and mesh gauge wire, with Class 2 zinc coating and top and bottom selvages twisted and barbed. PVC coating on fence fabric shall conform to ASTM F668, Class 2A, with minimum PVC thickness of 22 mils. Color shall be approved by Engineer.

B. Barbed Wire. Provide barbed wire conforming to ASTM A121, size 12-1/2 gauge wire, with four-point barbs, and Class three zinc coating.

C. Line Post. Provide line post with 2-1/4 inch hot-rolled "H" section of high carbon steel, minimum weight 3.26 lb/ft, or 2.375 inch O.D., Schedule 40 steel pipe, minimum weight 3.65 lb/ft, conforming to the strength requirements of ASTM F669.

D. End, Corner and Pull Post. Provide 2-1/2 inch square tubular steel end, corner and pull posts, minimum weight 5.59 lb/ft, conforming to ASTM A501, or 2.875 inch O.D., Schedule 40 steel pipe, minimum weight 5.79 lb/ft, meeting the strength requirements of ASTM F669.

E. Swing Gate Post. Swing gate posts shall be in accordance with ASTM A53 Schedule 40 for steel pipe, and ASTM A501 for steel tubing.

F. Cantilevered Gate Post. Gate post shall have four-inch O.D., Schedule 40 steel pipe, minimum weight 9.11 lb/ft, conforming to ASTM A53.

G. Top Rails. Top rails shall be 1.660 inch O.D., Schedule 40 steel pipe, minimum weight 2.27 lb/ft, meeting the strength requirements of ASTM F669, in random lengths averaging 20 feet, with minimum lengths of 10 feet.

H. Bracing. Bracing shall be 1.660-inch O.D., Schedule 40 steel pipe, minimum weight 2.27 lb/ft, meeting the strength requirements of ASTM F669.

I. Post and Line Caps. Fabricate post and line caps from pressed steel and hot-dip galvanized with a minimum of 1.2 oz/sf of zinc coating of surface area. Design line caps to fit snugly over posts and exclude moisture from inside when tubular posts are used.

J. Rail and Brace Ends. Fabricate rail and brace ends from pressed steel and hot-dip galvanized with a minimum of 1.2 oz/sf of zinc coating of surface area.

K. Sleeve-Type Coupling. Provide sleeve-type coupling from pressed steel or round steel tubing and hot-dip galvanized with a minimum of 1.2 oz/sf of zinc coating of surface area. Steel material to a minimum of 0.051 inch in thickness and a minimum of six inches in length. Fabricate sleeve to prevent movement along the rail.

L. Tie Wire and Wire Clips. Tie wires shall be nine-gauge, hot-dip galvanized with a minimum of 0.80 oz/sf of zinc coating of surface area in accordance with ASTM A641, Class 3. Wire clips to be six-gauge and hot-dip galvanized with a minimum of 0.80 oz/sf of zinc coating of surface area in accordance with ASTM A641, Class 3.

M. Tension and Brace Bands. Fabricate tension and brace bands from pressed steel and hot-dip galvanized with a minimum of 1.2 oz/sf of zinc coating of surface area. Tension and brace bands to be 11-gauge in thickness and 1/4 inch in width.

N. Tension Bars. Fabricate tension bars from merchant quality steel strip and hot-dip galvanized with a minimum of 1.2 oz/sf of zinc coating of surface area. Tension bars to be 1/4 inch in thickness by 3/4 inch in width. Minimum length of tension bar to be two inches less than full height of the chain link fabric.

O. Truss Rods. Fabricate truss rods from merchant quality steel rod and hot-dip galvanized with a minimum of 1.2 oz/sf of zinc coating. Truss rods shall be 3/4 inch in diameter.
P. Barbed Wire Extension Arms. Fabricate barbed extension arms from pressed steel and hot-dip galvanized with a minimum of 1.2 oz/sf of zinc coating of surface area. Fit extension arms with clips or slots for attaching the barbed wire to the extension arm. Provide extension arm capable of supporting a vertical 300 pound load attached where the outer strand of barbed wire would connect to the arm, without causing permanent deflection to the extension arm.

Q. Restraining Bar. Restraining bars shall be No. 4 galvanized steel bar.

2.02 FENCING GATES

A. Federal Specification RR-F-191K; Type II, double swing, double cantilever sliding. Shape and size of the gate frame shall be indicated on the Plans. Framing and bracing members shall be round or square of steel alloy. Provide steel member finish with zinc coating. Provide gate frames and braces to the minimum sizes listed in RR-F-191/3D for each class and grade except that steel pipe frames to be 1.90 inches O.D. x 0.120 inches minimum wall thickness.

B. Gate fabric and barbed wire on top of gate shall be as specified herein.

C. Provide zinc coating on steel latches, stop, hinges, keepers, and accessories.

D. Gate latches shall be plunger bar type. Gate leaves more than eight feet wide shall have intermediate members as necessary to provide rigid construction, free from sag or twist. Provide gate leaves less than eight feet wide with intermediate members as necessary to provide rigid construction, free from sag or twist.

E. Attach gate fabric to the gate frame in accordance with the manufacturer’s standards, except that welding will not be permitted. Arrange padlocking latches to be accessible from both sides of the gate, regardless of latching arrangement.

2.03 POST CONCRETE

A. Post concrete shall be class B in accordance with Section 03000, General Concrete Construction, using 3/4-inch maximum size aggregate. Grout shall be one part Portland cement to three parts clean, well-graded sand, with minimum amount of water added to produce a workable mix.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install chain link fence on previously prepared surfaces to the lines, grades and locations as shown on the Plans, or as directed by the Engineer. Install fence in accordance with the fence manufacturer’s written installation instructions, except as modified by these specifications.

B. Establish a graded fence line prior to fencing installation. Ensure ground along the fence line is solid, and earth fill used to establish the fence line is thoroughly compacted. Clear the fence line of trees, brush, protruding rocks greater than three-inches in diameter, or any other obstacles that will interfere with fencing.

C. Excavate for concrete-embedded items to dimensions indicated, except in bedrock. If bedrock is encountered before reaching required depth, continue excavation to depth indicated or 18 inches into bedrock, whichever is less, and a minimum of two inches larger than outside diameter of post. Clear post holes of loose material. Properly dispose of waste material.

D. Provide line posts spaced equidistant apart; not to exceed 10 foot centers maximum. Provide gate posts, as necessary, for the size of gate openings. Straight runs between braced posts shall not exceed 500 feet. Provide corner posts or pull posts with bracing in both directions for any change in direction of 15 degrees or more, and for any abrupt change in grade.
E. Set posts plumb. Set posts equal to or smaller than 2.875 inch O.D. pipe and 2-1/2 inch square tubular or "H" shapes, 36 inches minimum into ground except in bedrock. Set larger posts 48-inches minimum into ground. Set posts in post concrete with minimum of six-inch lateral concrete cover. Thoroughly compact concrete to eliminate voids. Top of concrete to be two inches above ground and crowned to shed water. In bedrock, set posts with a minimum of one inch of grout around each post. Thoroughly work grout into the hole to eliminate voids and finish in a dome. Cure concrete and grout a minimum of 72 hours before any further work is performed on posts.

F. Brace gate, corner, end and pull posts to the nearest post with a horizontal brace used as a compression member and a diagonal truss rod and turnbuckle used as a tension member.

G. Install restraining bar at midpoint of each span, anchored into ground and tied to fence fabric as shown on the Plans.

H. Install ground closure where drainage ditches or natural depressions cross the fence line.

I. Install post cap on terminal posts of six-foot fence. Provide hole in post cap to accommodate top rail on line posts.

J. Install barbed wire extension arms on line posts of six-foot fence. Provide hole in barbed wire extension arms to accommodate top rail. Set barbed wire extension arm at a 45-degree outward angle.

K. Install top rail before installing chain-link fabric. Join top rails with suitable sleeve-type couplings, making rigid connections with provisions for expansion and contraction. Pass rail through base of line post barbed wire extension arm and fasten securely to terminal post.

L. Install bottom wire before installing chain-link fabric, and pull wires taut. Install bottom tension wire eight inches off the respective fabric line

M. Pull fabric taut and secure fabric to top rail and bottom wire with tie wires, close to both sides of each post and at intervals of not more than 24 inches on centers. Secure fabric to terminal posts with a tension bar and tension bands spaced 14 inches apart. Secure fabric to line posts with tie wires or wire clips spaced 14 inches apart. Install fabric so that bottom of fabric is two inches above ground level. Install fence fabric to provide two-inch deflection at center of fabric span between two posts, when a force of approximately 30 pounds is applied perpendicular to fabric. Fabric should return to its original position when force is removed.

N. Install three strands of barbed wire on barbed wire extension arms above fence posts. Extend terminal posts sufficiently above top rail to carry three strands of barbed wire in horizontal alignment with barbed wire strands on extension arms. Extend each end member of gate frames sufficiently above top member to carry three strands of barbed wire in horizontal alignment with barbed wire strands on the fence. Pull each strand taut and securely fasten each strand to each extended post or member. The method of securing wires shall be positive and complete and in accordance with the fence manufacturer's recommendations.

O. Install wing gates to swing through 180 degrees from closed to open.

3.02 CLEANUP

A. Remove waste fencing materials and other debris from the fencing site.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION
A. This section describes materials and services required to revegetate areas disturbed by construction activities, and other areas to be revegetated as shown on the Plans. Revegetation includes, but is not limited to, application of seed mixes, planting of container plants and cuttings, straw mulching, establishment of plant materials, weed control and maintenance of seeded and planted areas for a two-year period following the date of filing of the Notice of Completion.

1.02 RELATED WORK SPECIFIED ELSEWHERE
A. Section 02110 Clearing and Grubbing
B. Section 02200 Earthwork
C. Section 02315 Portal Area Development
D. Section 02830 Fencing

1.03 DEFINITIONS

1.04 SUBMITTALS
A. List of plant materials and seeds to be provided, with quantities of each and sources indicated, no later than 60 days after Notice to Proceed. Indicate that the materials specified will be available at anticipated installation date, or are to be contract grown.
B. Delivery certificates for container plant materials stating source, quantity, type of material (container size, genus and species), and that plant materials conform to the specifications. Certificates shall be submitted prior to approval to begin planting.
C. Seed bag certification tags and a signed certificate listing the quantity and type of seed. Tags shall include seed type (genus and species), quantity (weight), analysis, name of supplier, seed purity percentage, seed germination percentage, weed seed content, and date seed was tested.
D. Source, supplier's and manufacturer's literature for bulk material samples, and samples of up to half a pound of mulch and soil stabilizers.
E. Furnish bulk material delivery certificates of each delivery stating source, quantity, type of material, and that material conforms to specifications. For mulch and binders in containers, furnish a certificate stating total quantity by weight and volume for each material.
F. Provide a schedule of revegetation work consistent with regulatory permits and requirements herein, prior to commencement of revegetation work.
G. Samples of two ounces of each individual species' seed, drawn at the time of each seed delivery to site.
H. Three samples of plant materials and cuttings for each variety and size specified delivered to the site a minimum of three days prior to planting operations. Approved samples shall be inspected by the Engineer for conformity to the requirements herein and shall remain on the site and shall be maintained by the
Contractor as standards of comparison for plant materials to be furnished. Upon acceptance of plant materials, approved samples shall be tagged and incorporated into the work.

I. Reports on the status of revegetation activities. Status reports shall be submitted with the Contractor’s daily reports.

J. Qualifications of revegetation specialists.

1.05 QUALITY ASSURANCE

A. Contractor qualifications: Perform work in accordance with best standards of practice under continuous supervision of a qualified, experienced revegetation specialists capable of interpreting the specifications and distinguishing the various vegetation types encountered in execution of the work.

B. The Contractor or subcontractor performing revegetation shall possess valid California Contractor License, Class C-27.

C. Nursery qualifications: All plant nurseries providing materials shall possess a valid California Nursery License and shall show proof of growing the type of specified plants a minimum of five years. Plant and seed materials shall meet applicable inspections required by law.

D. Review and conform to all permits, and regulatory requirements applicable to revegetation of this project, as issued by the California Department of Fish and Game, United States Fish and Wildlife Service, Army Corps of Engineers, Regional Water Quality Control Board and any of the federal, state or local regulatory agency. Copies of permits will be provided to the Contractor by the Engineer.

E. The type and amount of herbicides shall be prescribed by a licensed pest control advisor. Herbicides shall be in accordance with the manufacturer’s product label and all applicable regulations. Do not use pre-emergent herbicides.

1.06 REJECTION AND SUBSTITUTION

A. Plants, seeds, and other revegetation materials not conforming to the requirements specified herein shall be considered defective, and such materials, whether in place or not, shall be marked as rejected, removed from the site, and replaced with acceptable materials. The Engineer may reject entire lot of plants represented by defective samples.

B. Make no substitutions from specified plant, seed, or other specified revegetation materials without written approval of the Engineer. All requests for substitute plant and seed materials shall be submitted to the Engineer a minimum of 30 days prior to the scheduled seed application or planting date.

1.07 SEQUENCING AND SITE CONDITIONS

A. Prior to the start of work, examine site conditions, and locate all environmentally sensitive areas, and other features, so that precautions may be taken not to damage such areas. In the event of conflicts between environmentally sensitive areas and the work of this section, promptly notify the Engineer. Provide for the protection of environmentally sensitive species and habitats within and adjacent to the work areas at all times.

B. With the exception of surveying and collection of seeds or plant cuttings, no construction or other disruptive activities (including soil testing or other form of surface disturbance) may occur in or adjacent to environmentally sensitive areas without prior written approval from the Engineer.

C. Planting and seeding shall not start in any area prior to inspection and approval of site preparation work, which includes topsoil replacement, weed control and soil preparation.

D. Install container plants and cuttings, where shown, prior to seeding.
1.08 SITE OBSERVATION VISITS

A. Schedule site observation visits with the Engineer prior to the start of each of the activities listed below. Provide a minimum of two and not more than ten working days advance notice for each day in which the following activities will occur.

1. Commencement of work for verification of existing conditions and locations of environmentally sensitive areas.
2. Topsoil salvaging for review of salvage and stockpile procedures.
3. Completion of backfilling and grading.
4. Replacement of salvaged topsoil and soil preparation.
5. Delivery of plant materials and when the plants and cuttings are spotted in place for planting, but prior to excavation of planting holes.
7. Seeding and straw mulching operations.
8. Plant watering.

B. The cost to the Water Authority associated with any testing, sampling and inspection scheduled by the Engineer on account of the advance notice provided by the Contractor that is delayed or prevented from occurring on the scheduled day due to insufficient progress or other fault of the Contractor, shall be backcharged to the Contractor and deducted from future partial or final payments.

PART 2 - PRODUCTS

2.01 FIBER MULCH

A. Provide fiber mulch consisting of a green-dyed virgin wood cellulose fiber mulch containing no germination or growth inhibiting factors. Suppliers shall certify that their products meet all specified requirements based on laboratory and field testing. Weight specifications of this material shall refer to air dry weight of fiber material. Absolute air dry weight is based on normal standards of Technical Association of Pulp and Paper Industry for wood cellulose and is considered equivalent to 10 percent moisture. Each package of cellulose fiber shall be marked by manufacturer to show air dry weight content.

2.02 SEED MATERIALS

A. A general seed mix shall consist of the following:

<table>
<thead>
<tr>
<th>Species/Common Name</th>
<th>Min. % Purity</th>
<th>Min. % Germination</th>
<th>lb. per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plantago insularis/Plantain</td>
<td>98</td>
<td>75</td>
<td>25.0</td>
</tr>
<tr>
<td>Lotus scoparius/Deerweed</td>
<td>90</td>
<td>60</td>
<td>5.0</td>
</tr>
<tr>
<td>Lupinus succulentus/Arroyo Lupine</td>
<td>98</td>
<td>85</td>
<td>2.0</td>
</tr>
<tr>
<td>Lasthenia chrysostoma/Goldfield</td>
<td>50</td>
<td>60</td>
<td>1.0</td>
</tr>
<tr>
<td>Phacelia ramosissima/Phacelia</td>
<td>95</td>
<td>85</td>
<td>1.0</td>
</tr>
</tbody>
</table>

B. Seed not required to be labeled under the California Food and Agriculture Code shall be tested for purity and germination by a seed laboratory certified by the Association of Official Seed Analysts, or a seed
technologists certified by the Society of Commercial Seed Technologists. Seed shall have been tested for purity and germination not more than one year prior to application of seed.

C. Deliver to the jobsite seeds for each plant species in separate, scaled containers. Perform proportioning by weight and mixing of seed mixes in the field in the presence of the Engineer immediately prior to application.

2.03 SOIL STABILIZER

A. Soil stabilizer will be a 100 percent organic tackifier, supplied in powder form and comprised of at least 83 percent pure mucinoid derived from organic sources. Tackifier will be water soluble, non-toxic, hydrophilic and will not inhibit germination. Acceptable products include "M-Binder," or equal.

2.04 STRAW MULCH

A. Provide certified clean, weed free rice straw.

2.05 STRAW WATTLES

A. Straw wattles shall be manufactured from rice straw and be wrapped in a tubular plastic netting. The netting shall have a strand thickness of 0.30 inch, a knot thickness of 0.55 inch and a weight of 0.35 oz/ft, and shall be made from 85 percent high density polyethylene, 14 percent ethyl vinyl acetate, and 1 percent color for UV protection. Straw wattles shall be nine inches in diameter, 25 feet long and weight approximately 30 pounds.

B. Wood stakes for anchoring straw wattles shall be 3/4-inch-square and 24 inches long.

2.06 PLANT MATERIALS

A. Plant materials shall consist of container-grown plants as described herein. Provide container plants in accordance with the planting schedule shown on the Plans.

B. Provide plant materials typical for variety and species, sound, healthy, vigorous, and free from plant disease, insect pests or eggs. Provide plants with healthy, normal root systems. Do not prune plants or trees prior to delivery.

C. Provide container plants which have been grown in containers for a period of time sufficient to develop root growth to hold soil ball together to side and bottom of container in which it was delivered, but not to the point of being root bound.

D. Do not grow container plants with stakes, nor prune into unnatural forms. Only plants with natural shapes and growth forms will be accepted.

2.07 CUTTINGS

A. Provide cuttings which originate from the same watershed in which they are to be planted. Collect cuttings during the plant dormancy (leafless) period of December 15 to February 15, or as determined by the Engineer.

B. Cuttings shall be 24 inches in length and between 1/2 inch and one-inch in diameter. Cut the base of each cutting at a 45-degree angle to distinguish the planting end from the growing top.

PART 3 - EXECUTION

3.01 DELIVERY, STORAGE AND HANDLING

A. Deliver seed in unopened supplier's sealed containers bearing original certification labels. Label seed according to state and federal laws.
B. Keep seed materials, during delivery and when temporarily stored on site, in a cool dry place, protected from moisture, wind, heat, vandalism, rodents, insects, weather and other conditions that would damage or impair viability of seed.

C. Keep container plants and cuttings, during delivery and when temporarily stored on site, in a cool place, protected from wind, heat, vandalism, rodents, insects, weather, desiccation and other conditions that would damage plants. Care shall be taken in handling plants to prevent damage to stems and trunks.

D. Water container plants to maintain soil moisture and to prevent desiccation or damage to root ball or leaves.

E. Store container plants and seed materials on site for no longer than two weeks.

F. The Engineer may reject any plant material damaged due to mishandling.

3.02 VERIFICATION OF SITE CONDITIONS

A. Locations of plant materials as shown on the Plans are approximate only. Before proceeding with any work, verify all dimensions and quantities and inform the Engineer of discrepancies between contract documents and actual conditions. Do not perform work in any area where a discrepancy exists.

3.03 WEATHER

A. Perform planting and seeding during periods when weather and soil conditions are normal for season and suitable in accordance with locally accepted horticultural practice. Apply hydroseeding and straw mulching only when winds are calm. Do not apply hydroseeding during rainy weather or when the soil temperature is below 40 degrees F.

3.04 SOIL PREPARATION

A. Mechanically scarify (rip) the soil surface to roughen and alleviate compaction prior to seeding. Thoroughly scarify areas to be planted and seeded with ripper blades spaced 12 inches apart to a depth of 12 inches.

B. Leave soil surface in acceptable condition, suitable for seeding, installation of container-grown plants or cuttings.

C. Verify adequacy of soil preparation in revegetation areas with the Engineer prior to initiating seeding and planting operations.

3.05 EROSION CONTROL

A. Continuously control erosion as specified herein and in accordance with measures shown on the Plans or the SWPPP. Erosion control measures shall be implemented and maintained throughout the warranty period. Remove temporary erosion control measures that will not be a part of the permanent erosion control plan.

B. Immediately notify the Engineer of any situation requiring additional erosion control devices to prevent soil erosion or sedimentation into any area beyond the project limits.

C. Monitor for erosion within revegetation areas and provide measures to prevent gullies, rill and sheet erosion, and silt deposition from occurring. Erosion control shall emphasize prevention. Repair erosion as required and include redirection or dissipation of the water source and recontouring of soil, followed by seeding, mulching, or planting. Strategically placed and secured straw wattles, hay bales or sandbags may be used to dissipate water sources.

D. Use methods and materials for re-hydroseeding, or planting of eroded areas consistent with the requirements herein. Do not use invasive exotic species for erosion control.
3.06 CONTAINER PLANTING

A. Spot planting locations for container plants in place prior to planting. Relative position of all plants is subject to approval by the Engineer.

B. Prior to installing plants, build moisture reserve in soil by twice filling excavated plant holes with water and allowing to drain naturally.

C. Set plants in center of plant hole, in vertical position, so that after allowing for watering and settling, the crown of root ball is 1 inch above surrounding finish grade.

D. Backfill around plant root balls with native topsoils from the site, excluding rock greater than two inches. Do not use muddy soil. Backfill by gently tamping down soil to remove air pockets. Do not fill around trunks or stems. Cut off all broken or frayed roots.

E. Do not allow plants to dry out before or while being planted. Keep exposed roots moist at all times during planting operations. Do not expose roots to air except while being placed in ground.

F. Remove and replace any plants not properly handled, spotted or planted.

G. Upon delivery, plant root systems shall be inspected by the Engineer to ensure that roots are both straight and well established. Plants with coiled roots will be rejects.

H. Construct raised earthen berms around each container plant installed to create water basins. Construct basins approximately four-feet in diameter, with berms three inches high.

I. Water each plant immediately after planting. Backfill any voids or settlement with additional topsoil. Allow topsoil surface to naturally drain, then repeat the watering.

3.07 CUTTINGS

A. Collect cuttings no earlier than 24 hours prior to planting. Place cuttings out of direct sunlight in a cooler maintained at a temperature between 35 degrees and 45 degrees F. Do not, at any time, expose cuttings to dry conditions for more than 10 minutes prior to planting and watering.

B. Spot locations for cuttings prior to planting. Relative position of all cuttings is subject to approval by the Engineer.

C. Plant cuttings after topsoil replacement operations are complete. Plant cuttings so that 2/3 of the cutting length is placed below ground. Space cuttings every four feet on-center.

D. Remove and replace any cuttings not properly handled, spotted or planted.

E. Water each cutting immediately after planting. Backfill any voids or settlement with additional topsoil. Allow topsoil surface to naturally drain, then repeat the watering.

3.08 HYDROSEEDING

A. Hydroseeding shall consist of a slurry mix of seed, soil stabilizer, fiber mulch, water and other approved additives. The mix shall include 2000 lb/acre of fiber mulch, 100 lb/acre of soil stabilizer, seed materials as specified and water as required to prepare a mix that shall become uniformly suspended to form a homogeneous slurry, that when hydraulically sprayed on the ground, will form a blotter-like ground cover impregnated uniformly with seeds and which, after application, will allow absorption of moisture and rainfall to percolate to underlying soil.

B. Use hydraulic hydroseeding equipment, with a built-in agitation system and sufficient operating capacity to continuously agitate, suspend and homogeneously mix the slurry. Use distribution lines of sufficient size to prevent stoppage and provide even distribution of slurry. Use traveling unit hydroseed equipment capable
of placing slurry tank and spray nozzles within sufficient proximity of areas to be hydroseeded so as to provide uniform distribution without waste. Limit the operation of hydraulic hydroseeding equipment to access roads to prevent soil compaction or damage to seeded areas. Provide extension hoses, as necessary, to reach all areas to be hydroseeded. Damage to prepared ground surface resulting from hydroseed application shall be repaired and reseeded at the direction of the Engineer.

C. Apply hydroseed within 30 days after topsoil replacement operations are complete. Perform topsoil replacement coincident with backfilling operations.

D. Mix hydroseed slurry immediately prior to hydroseed application. Do not allow slurry to remain in the tank for more than one hour before application.

E. Apply the slurry in a one step application. Using the wood fiber as a guide, spray soil with uniform visible coat of slurry in sweeping motion, allowing wood fibers to build upon each other, until complete, even coverage is achieved.

F. Apply hydroseed to all areas disturbed during construction, with the exception of permanent access roads, structures, or other areas designated for other revegetation as shown on the Plans. Designated slope areas are subject to approval by the Engineer.

3.09 IMPRINT SEEDING

A. Use imprint seeding methods only in areas designated on the Plans. Imprint seed to areas disturbed during construction, with the exception of permanent access roads, structures, or other areas designated for other revegetation as shown on the Plans. Use imprint seeding after topsoil replacement operations are complete. Perform topsoil replacement coincident with backfilling operations.

B. Imprint seeding equipment shall consist of a heavy weighted roller with minimum core diameter of 20 inches, and a length of eight feet or less. The roller shall form discontinuous, v-shaped troughs on the soil surface that produce corresponding soil imprint patterns when towed. The imprint roller shall have teeth between four inches and 10 inches in height. Teeth shall be v-shaped in transverse section and rectangular or triangular in longitudinal section. Crest to crest spacing between teeth shall be one foot or less and the angle between front and rear faces of imprinting teeth shall be 60 degrees or less. The imprint roller shall provide a minimum static pressure on the soil surface between 10 psi and 50 psi. Provide a minimum of one imprint pattern per every square foot of area imprinted. The imprint shall cover a minimum of 70 percent of the area imprinted.

C. Attach a calibrated seed bin on top or directly in front of the imprinting roller to distribute seed mixes. Thoroughly clean the seed bin prior to use. Do not allow residual seeds remaining from previous uses in the seed bin.

D. Mix seed with wheat bran or approved substitute to aid in calibrating seed application rate and to prevent seed segregation. Determine the mixing ratio in the presence of the Engineer at the seeding site immediately prior to commencing with imprint seeding. Do not allow seed and bran mixture to remain in seed bin for more than four hours.

E. Seed bin shall drop seeds onto or directly in front of imprinting roller during application. Rollers shall immediately firm seeds into contact with soil.

3.10 STRAW MULCHING

A. Apply straw mulching on all slopes 2:1 or steeper, and as designated on the Plans, promptly after topsoil replacement operations are complete. Apply straw mulching in a four-step operation as follows:

1. Hydroseed areas with the specified seed mix, except that the quantity of fiber mulch in the mix shall be reduced to 1700 lb/acre and the soil stabilizer shall be removed.
2. Uniformly apply straw at a minimum rate of 4000 lb/acre. When weather conditions are suitable, straw may be pneumatically applied by equipment that will not render the straw unsuitable for incorporation into the soil. Use hand spreading or other means where pneumatic equipment is unable to reach the limits for straw mulching.

3. Roll straw into soil surface with studded steel plate straw roller equipment capable of forcing straw into the soil to a sufficient depth to tie down the surface soils. Steel plate studs shall be at least six inches wide, and approximately one inch thick, with rounded edges.

4. Apply a fiber mulch mix consisting of 300 lb/acre fiber mulch and 100 lb/acre soil stabilizer over the rolled straw.

3.11 STRAW WATTLES

A. Install straw wattles, where shown on the Plans, on slopes with minimum spacing as follows:

<table>
<thead>
<tr>
<th>Gradient</th>
<th>Measured Slope Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:1 or steeper</td>
<td>20 feet apart</td>
</tr>
<tr>
<td>1:1 to 2:1</td>
<td>30 feet apart</td>
</tr>
<tr>
<td>2:1 to 3:1</td>
<td>50 feet apart</td>
</tr>
</tbody>
</table>

B. Install straw wattles across the full width of the restored area level to the slope contour, in three-inch deep trenches. Anchor straw wattles with wood stakes at four-foot intervals, with additional stakes at each end. Tightly abut the ends of adjacent straw wattles to each other. Do not overlap ends.

3.12 CLEAN UP

A. Keep all work areas clean, neat and orderly at all times.

B. Upon completion of revegetation work, remove rubbish, trash, and debris resulting from the revegetation operations.

C. Remove oversprayed hydroseeding and straw from walks, lights, access roads, streets, fences, structures, etc.

D. Remove any detrimental, non-native plants growing in the work area not specified in the seed mix.

3.13 ESTABLISHMENT MAINTENANCE

A. The establishment maintenance period will begin on the first day following completion and acceptance of the revegetation work. Continue the establishment maintenance activities for a period of two years following the date of filing of the Notice of Completion (i.e., the contract warranty period), and as specified herein.

B. Maintain all container plants and cuttings in a vigorous, thriving condition by proper watering, weed control, clean up, general care, and any other means necessary.

C. Provide water, as necessary, to plantings during the establishment period. Determine watering frequency by checking soil moisture levels to prevent wilting or other damage to plant materials.

D. Apply water in a manner that ensures deep penetration into the soils surrounding the plant root balls. Fill plant basins until the soil around the roots is moist from the bottom of the hole to the top of the ground. Filling the plant basins several times per watering event may be required.

E. Inspect and repair plant basins as needed prior to each watering.
F. Perform weed control as specified herein, or as directed by the Engineer.

G. Make inspections at a minimum of every three months to ensure plant materials are healthy and free of insect infestations and plant diseases. Report any findings to the Engineer. Remove diseased plants and replace them to prevent the spread of diseases and insects.

H. Monitor plant materials for damage caused by animals, and inform the Engineer of such damage. Propose remedial actions to the Engineer for approval. Provide remedial actions, such as fencing.

I. Remove and dispose of, all trash and litter accumulated during the establishment maintenance period.

J. At no time apply fertilizers, pesticides, or herbicides other than those specified to any of the planted or hydroseeded areas without the written approval of the Engineer. Biological control agents, such as insect predators, may be used with the approval of the Engineer.

K. During the establishment maintenance period, replace in like kind and size to the same specifications required for original planting all plants which die, are unhealthy, or diseased. All replacement planting shall be performed within 30 days receipt of written notice provided by the Engineer.

3.14 WEED CONTROL

A. Control noxious and annual weeds in all areas to be planted and hydroseeded during construction and throughout the establishment maintenance period. Within 10 days prior to initiating seeding and planting operations, perform weed eradication. Noxious and annual weeds are identified as follows:

1. Noxious weeds are perennial weeds that pose a threat to establishment of revegetation areas and resprout from underground roots. A general list of noxious weeds targeted for control include Artichoke thistle (Cynara cardunculus), Fennel (Foeniculum vulgare), Castor bean (Ricinus communis), Tree tobacco (Nicotiana glauca), Pampas grass (Cortaderia spp.), Bermuda grass (Cynodon dactylon), Tamarisk (Tamarix spp.), Eucalyptus (Eucalyptus spp.), Acacia (Acacia spp.), Hottentot fig (Carpobrotus spp.) palms (phoenix spp. and Washingtonia spp.), Gazania (Gazania spp.), and Giant reed (Arundo donax).

2. Annual weeds are those that pose a threat to establishment of revegetation areas due to vigorous, competitive growth habits. A general list of annual weeds targeted for control include tall annual grasses of various species, Mustard (Brassica spp.), Russian thistle (Salsola australis), Medic (Medicago spp.), Sweet-Clover (Melilotus spp.), Wild radish (Raphanus spp.), Tocalote (Centaurea melitensis), Garland chrysanthemum (Chrysanthemum coronarium), and Cocklebur (Xanthium spinosum and X. strumarium).

3. Other weeds may be identified for control by the Engineer during the establishment maintenance period.

B. All areas shall be weeded prior to the weeds reaching 12 inches in height or before ripening of seed.

C. Employ weed control methods as follows:

1. Train personnel to be knowledgeable in the identification of weed species and desirable seeded and planted species to ensure only the spraying and removal of weed species.

2. Control noxious weeds and their root systems by cutting top growth off and spot spraying the stumps with an approved herbicide that will translocate to the roots. Top growth, seed heads and plant mass shall be removed from the site.

3. Control annual weeds by either pulling out by hand or hoeing. The stems of the hoed plants will be cut below ground level. Weed plant mass shall be removed from the site.
D. Leaf and branch drop, and other organic debris of species not identified as weeds may be left in place.
3.15 PERFORMANCE STANDARDS DURING PLANT ESTABLISHMENT PERIOD

A. At six-month intervals following the completion of planting, or at other intervals as directed by the Engineer, inspect the container plants in the presence of the Engineer and determine the plant survival rate. At each inspection, should the mortality rate of any individual species exceed 10 percent of the original number of that species, or should the mortality rate of the total planting exceed 10 percent of the total original number of container plants, or at the completion of the warranty period should the plant mortality rate of any individual species exceed 20 percent of the original number, or should the mortality rate of the total planting exceed 20 percent of the total original number of container plants, plant additional container plants of like kind and to original numbers and size as specified herein for the original planting. Warranty replacement plants for the duration of the warranty period, but in no case for less than eight months.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes supply and placement of cast in place concrete, as shown on Plans and specified in this section.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02200 Earthwork
B. Section 02510 Access Roads
C. Section 02330 Concrete Backfill and Grouting for Tunnels
D. Section 03480 Precast Concrete Vaults
E. Section 05120 Structural Steel, Aluminum and Miscellaneous Metalwork
F. Section 09820 Crystalline Waterproofing
G. Section 09900 Painting and Coating
H. Section 15142 Wall Pipes, Seep Rings, and Penetrations
I. Section 15891 PVC Pipe Vent Systems

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Concrete Institute
   304 Guide for Measuring, Mixing, Transporting, and Placing Concrete.
   304.2R Placing Concrete by Pumping Methods.
   305 Hot Weather Concreting.
   306 Cold Weather Concreting.
   308 Standard Practice for Curing Concrete.
   318 Building Code Requirements for Reinforced Concrete.
   347 Guide to Formwork for Concrete.

B. American Society for Testing and Materials
   A185 Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
   A497 Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.
   A615 Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   C31 Practice for Making and Coring Concrete Test Specimens in the Field.
C33  Specification for Concrete Aggregates.
C39  Test Method for Compressive Strength of Cylindrical Concrete Specimens.
C42  Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
C94  Specification for Ready-Mixed Concrete.
C143 Test Method for Slump of Hydraulic Cement Concrete.
C150 Specification for Portland Cement.
C171 Specification for Sheet Materials for Curing Concrete.
C231 Test method for Air Content of Freshly Mixed Concrete by the Pressure Method.
C260 Specification for Air-Entraining Admixtures for Concrete.
C309 Specification for Liquid-Membrane Forming Compounds for Curing Concrete.
C494 Specification for Chemical Admixtures for Concrete.
D412 Test Methods for Rubber Properties in Tension.
D624 Test Method for Rubber Property-Tear Resistance.
D1751 Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction.
D1752 Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

C. Concrete Reinforcing Steel Institute

D. State of California, Department of Transportation, Manual of Test Volumes 1-2-3 (Standard Test Methods)
   Test 417 - Testing Soils and Waters for Sulfate Content.
   Test 422 - Testing of Soils and Waters for Chloride Content.

E. U.S. Corps of Engineers
   CRD-C572 Poly Vinyl-Chloride Waterstops.
   CRD-C588 Nonshrink Grout.

1.04 SUBMITTALS

A. Manufacturer's catalog, data and descriptive literature for form ties, spreaders, corner formers, form coatings, curing methods, curing materials, curing compound, bond breakers, joint sealant, backing rod, joint filler, epoxy bonding compound, color additive and other admixtures. Compounds that will come in contact with potable water shall be certified by the National Sanitation Foundation.

B. Mill test certificates identifying chemical and physical analyses of each load of reinforcing steel delivered. If mill test reports are unavailable and the quantity of steel for a structure exceeds five tons, provide a laboratory test to prove conformance with the specified ASTM standard.
C. Reinforcing bending lists and drawings for placing all reinforcing. Placing drawings shall indicate openings (mechanical, electrical, equipment, and architectural) including additional reinforcing at openings and corner bar arrangements at intersecting beams, walls, and footings indicated in the typical details and structural details. Placing drawings shall show bar lengths, bar locations, bar sizes, etc. Placing drawings shall be coordinated with the concrete placing schedule. Each bending list and placing drawing submitted shall be complete for each major element of a structure (grade slabs, footings, walls, deck, floor, or roof slabs) including dowels and corner bars.

D. Concrete mix designs.

E. Six copies of a report from a testing laboratory verifying that aggregate material contains less than 1 percent asbestos by weight or volume and conforms to the specified gradations.

F. Detailed calculations and drawings of formworks, false-works, schedule and procedures of forms removal.

G. Furnish delivery ticket for each load of concrete. The delivery ticket shall provide all information in accordance with ASTM C94, Section 16, Batch Ticket Information.

1.05 CONCRETE TESTS

A. Concrete quality testing will be performed on the concrete by the Engineer as follows:

1. Frequency of Sampling: Cast four concrete test cylinders from each 50 cubic yards, or fraction thereof, of each class of concrete placed in any one day. Sampling and curing of cylinders to conform to ASTM C31.

2. Strength Testing: Test cylinders in accordance with ASTM C39. Test one cylinder at seven days for information; test two cylinders at 28 days for acceptance; and hold one cylinder for verification. Strength acceptance will be based on the average of the strengths of the two cylinders tested at 28 days. If one cylinder of a 28 day test manifests evidence of improper sampling, molding, or testing, other than low strength, discard it and use the fourth cylinder for the test result.

3. Determine concrete slump by ASTM C143 with each strength test sampling and as required to establish consistency.

4. Determine air content of the concrete using ASTM C231 to verify the percentage of air in the concrete immediately prior to depositing in forms.

5. The average concrete strength value shall meet the strength test requirements of ASTM C94.

6. If the 28 day strength tests fail to meet the specified minimum compressive strength, the concrete will be assumed to be defective and one set of three cores from each area may be taken as selected by the Engineer in accordance with ASTM C42. If the average compressive strength of the set of three concrete cores fails to equal 90 percent of the specified minimum compressive strength, or if any single core is less than 75 percent of the minimum compressive strength, the concrete will be considered defective. The Engineer may require additional coring, nondestructive load testing, or repair of defective concrete. Costs of coring, testing of cores, load testing, and required repairing pertaining thereto shall be paid by the Contractor.

B. To facilitate concrete sampling and testing:

1. Furnish labor to assist the Engineer in obtaining and handling samples at the project site.

2. Advise the Engineer in writing two working days in advance of concrete placing operations to allow for scheduling and completion of quality testing.

3. Provide and maintain facilities for safe storage and proper curing of concrete test specimens on the project site, as required by ASTM C31.
PART 2 - MATERIALS

2.01 FORMWORK

A. Provide forms conforming to ACI 347R.

B. Class I Forms: Use steel forms, ply form, or smooth-surface plywood 3/4 inch minimum thickness for straight surfaces and 1/2 inch minimum thickness for curved surfaces.

C. Class II Forms: Use plywood in good condition, metal, or smooth-planed boards free from large or loose knots with tongue and groove or ship lap joints. Forms shall be oiled.

D. Class II forms may be used for exterior concrete surfaces which are one foot or more below finished grade. Use Class I forms for all other surfaces.

E. In all cases, pipe penetrations (including wall or seep ring) through concrete sections shall not be in contact with any ferrous materials including, but not limited to, reinforcing steel, form ties, or tie wire. Minimum clearances between any ferrous material and steel pipe (including wall or seep ring) shall be 1-1/2 inches. All reinforcing bars and form ties shall be secured in a manner so that concrete placement and vibration shall not displace ferrous materials onto the steel pipe. (Reference Section 15142-3 Wall Pipes, Seep Rings and Penetrations.)

2.02 FORM RELEASE AGENT

A. Only use form release agents which effectively prevent absorption of moisture and prevent bond with the concrete. Agent shall be nonstaining and nontoxic after 30 days.

B. For steel forms, release agent shall prevent discoloration of the concrete due to rust.

2.03 BOND BREAKER

A. Bond breaker shall be a nonstaining type which will provide a positive bond prevention, such as Silcoseal 77, as manufactured by SCA Construction Supply Division, Superior Concrete Accessories, or equal.

2.04 REINFORCING STEEL

A. Reinforcement shall conform to ASTM A615, Grade 60.

B. Plans for fabrication and placing of reinforcing steel shall conform to ACI Detailing Manual.

C. Deliver reinforcing steel to the site bundled and tagged with identifying tags.

2.05 WELDED WIRE FABRIC


2.06 TIE WIRE

A. Tie wire shall be 16 gauge minimum, black, soft annealed.

2.07 BAR SUPPORTS

A. Bar supports shall be Class 1 - Plastic Protected, Class 2 - Stainless Steel Protected, to ASTM A497, or concrete dobies.
2.08 BAR COUPLERS

A. Reinforcing steel bar splicing couplers shall be a mechanical type as manufactured by Dayton Barssplice Inc., or equal. Couplers shall resist both tension and compression forces.

2.09 JOINT SEALANT

A. Joint sealant shall be a multipart, gray, nonstaining, nonsagging, polyurethane sealant, which cures at ambient temperature to a firm, flexible, resilient, tear-resistant rubber. Sealant shall be RC 270 of Products Research and Chemical Corporation, Mameco International Vulkem 277, Multi-Chem MC287, or equal.

2.10 BACKING ROD

A. Backing rod for expansion joints shall be an extruded closed-cell polyethylene foam rod, such as Minicel backer rod, manufactured by Industrial Systems Department, Plastic Products Group of Hercules, Inc., Middletown, Delaware; Ethafoam SB, as manufactured by Dow Chemical Company, Midland, Michigan, or equal. The rod shall be 1/4 inch larger in diameter than the joint width.

2.11 BOND BREAKER TAPE

A. Bond breaker tape shall be an adhesive-backed glazed butyl or polyethylene tape which will adhere to the premolded joint material or concrete surface. The tape shall be the same width as the joint. The tape shall be compatible with the sealant.

2.12 PREFORMED CONTROL JOINT

A. Preformed control joint shall be a one-piece, flexible, PVC joint former, such as Kold-Seal Zip-Per Strip KSF-150-50-50, manufactured by Vinylex Corp., Knoxville, Tennessee, or a one-piece steel strip with preformed groove, such as Keyed Kold Retained Kap, manufactured by Burke Concrete Accessories, Inc., San Mateo, California, or equal. Provide the preformed control joint material in full length unspliced pieces.

2.13 WATERSTOP

A. Waterstop shall be manufactured from plastic compound of PVC base to Corps of Engineers CRD-C-572, Polyvinyl-chloride waterstop, of tensile strength, ultimate elongation and tear resistance to ASTM D412 and D624.

2.14 PREMOLDED JOINT FILLER

A. Provide joint filler of closed cell synthetic foam of isomeric polymers conforming to ASTM D1752, with the compression requirement modified to 10 psi (7.03 g/mm²) minimum and 25 psi (17.58 g/mm²) maximum. The flexible foam joint filler shall be compatible with hot pour joint sealers, so that there will be no melting of the foam filler or foaming of the sealer. Provide "CEREMAR" joint filler as manufactured by W.R. Meadows, Inc., or equal. In all cases, joint filler, sealant bond breaker and backer rod shall be compatible.

2.15 CEMENT

A. Cement shall conform to ASTM C150, Type II, with maximum tricalcium aluminate not to exceed 8 percent. The maximum percent alkalies shall not exceed 0.6 percent.

2.16 AGGREGATES

A. Aggregates shall comply with ASTM C33 and shall contain less than 1 percent asbestos by weight or volume and be free from any substances that will react with the cement alkalies. Maximum chloride content for sand shall not exceed 200 mg/l per Caltrans test method 422. Obtain aggregate from approved sources.
2.17 WATER

A. Water shall be free of organic materials and other impurities that might reduce the strength, durability or other quality of the cement mortar. Water shall have a pH of 7.0 to 9.0, a maximum chloride concentration of 500 mg/l (per Caltrans test method 422), and a maximum sulfate concentration of 500 mg/l (per Caltrans test method 417).

2.18 COLOR ADDITIVE FOR EXTERIOR ELECTRICAL DUCT ENCASEMENT

A. For exterior electrical duct concrete encasements, use a color additive for identification purposes: coral red "Chromix C-22," as manufactured by L. M. Scofield Company, or equal. Add the color additive while the concrete is being mixed using the quantity per cubic yard of concrete recommended by the manufacturer for the class of concrete indicated.

B. For fiber optic cable concrete encasement, apply the orange color additive which is common to communication and CATV lines, as designated by Underground Service Alert of Southern California (DIGALERT/USALERT).

2.19 CONCRETE ADMIXTURES

A. Air-entraining admixtures shall conform to ASTM C260, and shall be nontoxic after 30 days and shall contain no chlorides. Admixtures shall be Master Builders MB-AE 90, Sika AER (Sikamix 104), or equal.

B. Water-reducing admixtures shall conform to ASTM C494, Type A or D, shall contain no chlorides, shall be nontoxic after 30 days, and shall be compatible with the air-entraining admixtures. The amount of admixture added to the concrete shall be in accordance with the manufacturer's recommendations. Admixtures shall be Master Builders Pozzolith polymer-type normal setting, Plastocrete (Sikamix 160) Normal Set, Sika Chemical Corporation, or equal.

C. Do not use any admixture that contains chlorides or other corrosive elements.

2.20 GROUT

A. Nonshrink grout shall conform to the Corps of Engineers Specification for Nonshrink Grout, CRD-C588, and to these specifications. Use a nongas-liberating type, cement base, premixed product requiring only the addition of water for the required consistency. Grout shall be Master Flow 713, or equal. Components shall be inorganic.

B. Ordinary type grout (dry pack) shall consist of one part portland cement to two parts sand by weight. Sand shall conform to ASTM C33 for fine aggregate, except that 100 percent of the material shall pass a No. 8 sieve. Add sufficient water to form a damp formable consistency.

C. Bonding grout shall be made of the same materials as ordinary type grout, except that one part portland cement shall be added to one part sand by weight.

2.21 MORTAR

A. Mortar placed on horizontal construction joints shall be a mixture of cement, sand, and water in the same proportions used in the concrete but with coarse aggregate omitted.

B. Mortar used for repair of concrete shall be made of the same materials as used for concrete, except that the coarse aggregate shall be omitted and the mortar shall consist of not more than one part cement to two and one-half parts sand by damp loose volume. The quantity of mixing water shall be no more than necessary for dry packing.
2.22 EPOXY BONDING COMPOUND

A. Epoxy bonding compound shall be Concresive 1001 LPL, Adhesive Engineering Company, San Carlos, California; Sikadur 32 Hi-Mod, Sika Chemical Corporation, Lyndhurst, New Jersey; EpoxTile 2391 by W. R. Grace and Company; Euco Epoxy 463 by Euclid Chemical Company; or equal.

2.23 CONCRETE MIX DESIGN

A. Conform to ASTM C94 ready-mixed concrete, except as modified by these specifications.

B. Air content as determined by ASTM C231 shall be 3 to 6 percent.

C. Use classes of concrete as described in the following table:

<table>
<thead>
<tr>
<th>Class</th>
<th>Type of Work</th>
<th>28-Day Compressive Strength (psi)</th>
<th>Minimum Cement Content (lb/CY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Structures, structure foundations, cradles, supports across pipe trenches, pipe encasements, cut off walls, and concrete not otherwise specified.</td>
<td>4,000</td>
<td>564</td>
</tr>
<tr>
<td>B</td>
<td>Pavement and concrete flatwork (i.e., access roads, sidewalks, curb, etc.)</td>
<td>3,000</td>
<td>470</td>
</tr>
<tr>
<td>C</td>
<td>Floor grout, miscellaneous un-reinforced concrete, mud slabs, pipe trench backfill, thrust blocks.</td>
<td>2,000</td>
<td>376</td>
</tr>
<tr>
<td>D</td>
<td>Lean Concrete</td>
<td>2,000</td>
<td>376</td>
</tr>
</tbody>
</table>

D. Measure slump in accordance with ASTM C143. Slump shall be as indicated below. A tolerance of up to one inch above the indicated maximum will be allowed for individual batches provided the average for all batches or the most recent 10 batches tested, whichever is fewer, does not exceed the maximum limit. Concrete of lower than usual slump may be used provided it is properly placed and consolidated.

<table>
<thead>
<tr>
<th>Type of Work</th>
<th>Slump (in.)</th>
<th>Tolerance (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slab on grade or heavy sections wider (in plan view) than three feet</td>
<td>2-1/2</td>
<td>plus 1/2, minus 1</td>
</tr>
<tr>
<td>Footings, suspended slabs, beams,</td>
<td>3</td>
<td>plus 1, minus 1</td>
</tr>
<tr>
<td>Walls and columns</td>
<td>4</td>
<td>plus 1, minus 1</td>
</tr>
<tr>
<td>Concrete Flatwork</td>
<td>2</td>
<td>plus 1, minus 1</td>
</tr>
<tr>
<td>Encasements and structural bases</td>
<td>4</td>
<td>plus 1, minus 1</td>
</tr>
<tr>
<td>Floor grout</td>
<td>4</td>
<td>plus 1, minus 1</td>
</tr>
</tbody>
</table>

E. The nominal maximum aggregate size shall not exceed the specified concrete cover on reinforcement, nor exceed 75 percent of the minimum clear lateral space provided between adjacent reinforcement, disregarding laps.
2.24 CURING COMPOUND
A. Curing compound shall conform to ASTM C309, Type 1, Class B.
B. Curing compound shall be compatible with required finishes and coatings.

2.25 CLEAR FLOOR HARDENER (SURFACE APPLIED)
A. Floor hardener shall be a colorless, aqueous solution of zinc and/or magnesium fluosilicate. Each gallon of the fluosilicate solution shall contain not less than two pounds of crystals. Hardener shall be Saniseal, a product of Master Builders Company, Cleveland, Ohio; Hornolith, a product of Grace Construction Materials, Cambridge, Massachusetts; Lapidolith, a product of Sonneborn, Minneapolis, Minnesota; or equal. The solution shall be delivered ready for use in the manufacturer's original sealed containers.

2.26 MATS, PAPER, AND SHEETING FOR CURING
A. Burlap mats shall conform to AASHTO Specification M182.
B. Waterproof curing paper and polyethylene sheets shall conform to ASTM C171.

2.27 FLY ASH
A. Fly ash is acceptable in the concrete mix for concrete Class A, B, C, and D, as defined herein. Fly ash shall conform to ASTM C618, Class F, and the Loss of Ignition shall not exceed 4 percent. Class F fly ash will be permitted to replace up to 15 percent of the required cement. Fly ash, as a percent by weight of total cementitious material, shall not exceed 17 percent, unless otherwise approved by the Engineer.
B. The Contractor shall furnish a Certificate of Compliance signed by the supplier identifying the type of fly ash and stating that the fly ash complies with ASTM C618, Class F, and these specifications. Supporting test data shall be furnished when requested by the Engineer. All testing and sampling procedures shall conform with ASTM C311.

PART 3 - EXECUTION
3.01 FORM TOLERANCES
A. Failure of the forms to produce the specified concrete surface and surface tolerance shall be grounds for rejection of the concrete work. Repair or replace rejected work as specified herein and as directed by the Engineer.
B. The following table indicates tolerances or allowable variations from dimensions or positions of structural concrete work and the planes or axes from which the tolerances are to be measured:

<table>
<thead>
<tr>
<th>Item</th>
<th>Tolerance (in.)</th>
<th>Measured From</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleeves and inserts</td>
<td>plus 1/4, minus 1/4</td>
<td>Centerline of sleeve or insert</td>
</tr>
<tr>
<td>Projected ends of anchors</td>
<td>plus 1/4, minus zero</td>
<td>Plane perpendicular to the end of the anchor as located on the Plans</td>
</tr>
<tr>
<td>Anchor bolt setting</td>
<td>plus 1/8, minus 1/8</td>
<td>Centerline of anchor bolt</td>
</tr>
<tr>
<td>Finished concrete every 10 feet</td>
<td>plus 1/4, minus 1/4</td>
<td>The concrete surface as located on the Plans</td>
</tr>
<tr>
<td>Finished concrete total length</td>
<td>plus 1/2, minus 1/2</td>
<td>The concrete surface as located on the Plans</td>
</tr>
</tbody>
</table>

C. Where equipment is to be installed, comply with manufacturer's tolerances if more restrictive than above.
3.02 FORM SURFACE PREPARATION

A. Clean form surfaces to be in contact with concrete of foreign material prior to installation.

B. Coat form surfaces in contact with concrete with a release agent prior to form installation in conformance with the release agent manufacturer’s recommendations.

C. Reuse only forms which provide a uniform surface texture on exposed concrete surfaces. Apply light sanding or other surface treatment between uses for uniform texture. Plug unused tie rod holes with corks, shave flush, and sand the concrete surface side. Do not patch forms other than filling tie rod holes, except in the case of Class II forms. Do not use metal patching discs on Class I forms.

3.03 REMOVAL OF FORMS

A. Leave forms and shoring for elevated structural slabs or beams in place until the concrete has reached a compressive strength equal to the specified 28 day compressive strength as determined by test cylinders. Do not remove supports and reshore. The following table indicates the minimum allowable time after the last cast concrete is placed before forms, shoring, or wall bracing may be removed:

<table>
<thead>
<tr>
<th>Formed Surface</th>
<th>Minimum Form Removal Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sides of footings and encasements</td>
<td>24 hours</td>
</tr>
<tr>
<td>Walls, columns, and similar members not supporting loads</td>
<td>48 hours</td>
</tr>
<tr>
<td>Shoring and forms for elevated slabs, beams, and girders</td>
<td>Until concrete strength reaches specified 28 day compressive strength</td>
</tr>
<tr>
<td>Wall bracing</td>
<td>Until top or roof slab concrete reaches specified 28 day compressive strength</td>
</tr>
</tbody>
</table>

B. Do not remove forms from concrete which has been placed with outside air temperature below 50 degree F without first determining if the concrete has properly set. Do not apply loading on green concrete. Immediately after forms are removed, carefully examine the surface of the concrete. Repair any irregularities in the surface and finished as specified.

3.04 FORMED OPENINGS

A. Provide openings as shown on Plans and of sufficient size to permit final alignment of pipes or other items without deflection or offsets of any kind. Allow space for packing where items pass through the wall to ensure watertightness. Provide a slight flare to facilitate grouting and the escape of entrapped air during grouting.

3.05 EMBEDDED ITEMS

A. Set anchor bolts and other embedded items accurately and hold securely in position until the concrete is placed and set. Check all special castings, channels, or other metal parts that are to be embedded in the concrete prior to and again after concreting. Check all nailing blocks, plugs, and strips necessary for the attachment of trim, finish, and similar work prior to concreting.

3.06 BEVELED EDGES (CHAMFER)

A. Form 3/4 inch beveled edges on exposed concrete edges and corners, beam soffit corners, and where indicated on the Plans. Reentrant corners in concrete members shall not have fillets, unless otherwise shown in the Plans. The top edges of slabs, walkways, beams, and walls may be beveled with an edging trowel in lieu of using chamfer strips.
3.07 CONSTRUCTION JOINTS

A. Provide layout of construction joints as shown on the Plans. The Engineer shall approve the location of all construction joints not shown on the Plans.

B. For slabs-on-grade use formed construction joints. Allow 24 hours between pours of adjacent slabs. Provide joints as specified or shown. Set continuous expansion joint strips between slabs and abutting vertical surfaces as indicated in the Plans.

C. For control joints, provide partial depth plastic strips set flush with finished surface or 1/8 inch wide joints cut with a diamond saw. Do not exceed 16 feet for the maximum spacing of control joints. Green cutting of construction joints will only be allowed upon approval of the Engineer.

D. Key construction joints unless otherwise detailed. Form keyways by beveled strips or boards placed at right angles to the direction of shear. Except where shown on the Plans or specified, provide keyways at least 1-1/2 inches in depth over at least 25 percent of the area of the section.

E. In case of emergency, place additional construction joints. Delays in excess of 45 minutes for placement of concrete constitute cause for an emergency construction joint. Emergency construction joints will not be allowed in structures designed to hold water.

F. When it is necessary to make a joint because of an emergency, furnish and place reinforcing dowels across the joint. Embed dowels 48 bar diameters each side of the joint. Size and number of dowels shall match reinforcing in the member. Furnishing and placing such reinforcing steel shall be at the Contractor's expense.

G. After the pour has been completed to the construction joint and the concrete has hardened, thoroughly clean the entire surface of the joint of surface laitance, loose or defective concrete, and foreign material, and expose clean aggregate by sandblasting the surface of construction joints before placing the new concrete. Cover horizontal construction joints with mortar. Spread uniformly and work thoroughly into all irregularities of the surface. The water-cement ratio of the mortar in place shall not exceed that of the concrete to be placed, and the consistency of the mortar shall be suitable for placing and working.

3.08 EXPANSION JOINTS

A. Provide expansion joints as shown on Plans with continuous edge reservoirs, which shall be filled with a joint sealant. Leave the material used for forming the reservoirs in place until immediately before the grooves are cleaned and filled with joint sealant. After removing edge forms from the reservoir, remove grout, loose concrete, and fins; then sandblast the slots. Allow the reservoirs to become thoroughly dry; then blow out the reservoirs and immediately prime and fill with the expansion joint sealant and backup materials. Use primer supplied by the same manufacturer supplying the joint sealant.

3.09 INSTALLATION OF PREMOLDED JOINT FILLER

A. Attach the filler to concrete with a bonding agent recommended by the joint sealant and joint filler manufacturer for compatibility.

3.10 INSTALLATION OF JOINT SEALANTS

A. Clean the joint cavity by sandblasting or power wire brushing. Install bond breaker tape per manufacturer's instructions.

B. Apply the primer, if required, and joint sealant with the equipment and methods recommended by the joint sealant manufacturer. Application criteria for the sealant materials, such as temperature and moisture requirements and primer cure time, shall be in accordance with the recommendations of the sealant manufacturer.
C. Apply masking tape along the edges of the exposed surface of the exposed joints. Trowel the joints smooth with a tuck pointing tool wiped with a solvent recommended by the sealant manufacturer.

D. After the sealant has been applied, remove the masking tape and any sealant spillage.

3.11 PLACING REINFORCEMENT

A. Place reinforcing steel in accordance with the current edition of ACI Detailing Manual.

B. Place reinforcing in accordance with the following, unless otherwise indicated:

1. Reinforcement indicated on the Plans is continuous through the structure to the farthest extent possible. Stop reinforcing bars two inches short from faces of concrete.

2. Splices may be used to provide continuity due to bar length limitations. Adjacent splices shall be staggered. The minimum length of bars spliced for this reason is 30 feet. Splicing of reinforcement which is detailed to be continuous on the Plans is not permitted.

C. Reinforcing steel, before being positioned and just prior to placing concrete, shall be free from loose mill and rust scale and from any coatings that may destroy or reduce the bond. Clean reinforcing steel by sandblasting or wire brushing as directed by the Engineer to remove materials that may reduce the bond.

D. Do not straighten or rebend reinforcing steel in the field. Do not use reinforcing with bends not shown in the Plans.

E. Position reinforcing steel in accordance with the Plans or Shop Drawings, and secure by using annealed wire ties or clips at intersections and support by concrete or metal supports, spacers, or metal hangers. Do not place metal clips or supports in contact with the forms. Bend tie wires away from the forms to provide the specified concrete coverage. Bars additional to those shown on the Plans, which may be found necessary or desirable by the Contractor for the purpose of securing reinforcement in position, shall be provided by the Contractor at his own expense.

F. Place reinforcement a minimum of two inches clear of any metal pipe or fittings.

G. Secure reinforcing dowels in place prior to placing concrete. Do not press dowels into the concrete after the concrete has been placed.

H. Unless shown on the Plans, spacing limits, cover and tolerance of reinforcement steel, shall be governed by ACI 318.

I. Roll wire mesh used for reinforcement flat before placing concrete. Support and tie wire mesh to prevent movement during concrete placement. Lap wire mesh a minimum of 12 inches at splices.

J. Position dowels for masonry walls to occur at reinforced block cells.

3.12 PLACING CONCRETE

A. All reinforcement and formwork must be inspected and approved by the Engineer 24 hours in advance of placing concrete. Conform to ACI 304R.

B. Pumping of concrete shall conform to ACI 304.2R.

C. Conform to ACI 305 for placing during hot weather.

D. Conform to ACI 306 for placing during cold weather.

E. Place concrete as near as possible to final location to avoid excessive movement of concrete within forms.
F. Consolidate the concrete placed in the forms with a mechanical vibrator to provide a uniform concrete mass.

3.13 BONDING TO OLD CONCRETE
A. Coat the contact surfaces with epoxy bonding compound. Conform to the manufacturer's printed preparation and application instructions and recommendations.

3.14 GROUTING VALVE AND PIPE SUPPORT FOUNDATIONS
A. Block out the original concrete or finish off a sufficient distance below the bottom of the valve or pipe support base to provide for the thickness of grout shown on the Plans. After the valve or pipe support has been set in position and wedged to the proper elevation by steel wedges, fill the space between the bottom of the machinery base and the original pour of concrete with a pourable nonshrink grout.

3.15 BACKFILL AGAINST WALLS
A. Do not place backfill against walls until the concrete has obtained a compressive strength equal to the specified 28 day compressive strength. Where backfill is to be placed on both sides of the wall, place the backfill uniformly on both sides.
B. Do not backfill the walls of structures that are laterally restrained or supported by suspended slabs or slabs on grade until the slab is poured and the concrete has reached the specified 28 day compressive strength.

3.16 CONCRETE FINISHES
A. Formed surfaces include all surfaces formed by the use of formwork, such as walls, columns and beams. Where a formed surface finish is not shown on the Plans, it shall be as specified below:

<table>
<thead>
<tr>
<th>Finish</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-1</td>
<td>Buried concrete encasements, concealed surfaces which are to be covered as foundations, or in walls to be strapped and lined.</td>
</tr>
<tr>
<td>F-2</td>
<td>All types of interior or exterior surfaces which are not prominently exposed to public inspection and for which no other finishes are specified.</td>
</tr>
<tr>
<td>F-3</td>
<td>Surfaces of buildings and civil engineering structures which will not be seen.</td>
</tr>
<tr>
<td>F-4</td>
<td>Interior walls, panels, columns, beams, etc. in areas of all structures.</td>
</tr>
<tr>
<td>F-5</td>
<td>Exterior walls, panels, columns, beams, bridge facia, piers, soffits, parapets and railing, etc. of all structures.</td>
</tr>
<tr>
<td>F-6</td>
<td>Architectural or feature panels.</td>
</tr>
</tbody>
</table>

1. Finish F-1: Surface where roughness is not objectionable. No surface treatment is required other than filling tie holes and repairing defective concrete. Color variations and physical irregularities permitted.
2. Finish F-2: Surfaces that provide a key for plaster and other thick surface coverings. Abrupt changes shall not exceed 1/4 inch. Gradual variations shall not exceed 1/2 inch. Fill tie holes and depressions 3/8 inch and deeper.
3. Finish F-3: All permanently exposed surfaces smooth or textured which are not prominent or subject to close or frequent scrutiny. Abrupt changes shall not exceed 1/4 inch. Gradual variations shall not exceed 1/4 inch. Fill all tie holes and depressions 1/4 inch and deeper.
4. Finish F-4: All smooth or textured surfaces of structures where appearance and accurate alignment is of moderate importance as they are subject to frequent observation. The Contractor shall take precautions to avoid the incidence of discoloration, contamination, dusting, retardation and
efflorescence. Abrupt changes shall not exceed 3/16 inch. Gradual variations shall not exceed 1/4 inch. Fill all tie holes and depressions 3/16 inch and deeper.

5. Finish F-5: All smooth or textured surfaces of structures where appearance and accurate alignment is important as they are exposed to frequent close scrutiny. The Contractor shall take precautions to avoid the incidence of discoloration, contamination, dusting, retardation and efflorescence. Abrupt changes shall not exceed 1/8 inch. Gradual variations shall not exceed 1/4 inch. Fill all tie holes and depressions 1/8 inch or deeper.

6. Finish F-6: All smooth or textured surfaces of structures where appearance or accurate alignment and evenness of surface are of the greatest importance. The Contractor shall take precautions to avoid the incidence of discoloration, contamination, dusting, retardation and efflorescence. Abrupt changes shall not exceed 1/16 inch. Fill all tie holes and depressions 1/16 inch or deeper.

B. Unformed surfaces include all surfaces formed without the use of formwork, such as pavements and floors. After proper and adequate vibration and tamping, all unformed top surfaces of slabs, floors, walls, and curbs shall be brought to a uniform surface with suitable tools. The classes of finish specified for unformed concrete surfaces are as shown below:

<table>
<thead>
<tr>
<th>Finish</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-1</td>
<td>Grade slabs and foundations to be covered with concrete or fill material.</td>
</tr>
<tr>
<td>U-2</td>
<td>Floors to be covered with grouted tile or topping grout.</td>
</tr>
<tr>
<td>U-3</td>
<td>Slabs which are water bearing with slopes 10 percent and less. Interior slabs and floors to receive architectural finish.</td>
</tr>
<tr>
<td>U-4</td>
<td>Sloping slabs which are water bearing with slopes greater than 10 percent.</td>
</tr>
<tr>
<td>U-5</td>
<td>Slabs and floors at slopes greater than 10 percent that are subject to frost or ice conditions. Stairs.</td>
</tr>
<tr>
<td>U-6</td>
<td>Concrete Pavement.</td>
</tr>
</tbody>
</table>

1. Finish U-1: Sufficient leveling and screeding to produce an even, uniform surface with surface irregularities not to exceed 3/8 inch. No special finish is required.

2. Finish U-2: After sufficient stiffening of the screeded concrete, surfaces shall be floated finished with wood or metal floats or with a finishing machine using float blades. Excessive floating of surfaces while concrete is plastic and dusting of dry cement and sand on the concrete surface to absorb excess moisture will not be permitted. Floating shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture. Surface irregularities shall not exceed 1/4 inch. Joints and edges shall be tooled where shown.

3. Finish U-3: After the floated surface (as specified for Finish U-2) has hardened sufficiently to prevent excess of fine material from being drawn to the surface, steel troweling shall be performed with firm pressure such as will flatten the sandy texture of the floated surface and produce a dense, uniform surface free from blemishes, ripples, and trowel marks. The finish shall be smooth and free of all irregularities.

4. Finish U-4: Steel trowel finish (as specified for Finish U-3) without local depressions or high points. In addition, the surface shall be given a light hair-broom finish. Do not use stiff bristle brooms or brushes. Leave hair-broom lines parallel to the direction of slab drainage.

5. Finish U-5: Steel trowel finish (as specified for Finish U-3) without local depressions or high points. Apply a stiff bristle broom finish. Leave broom lines parallel to the direction of slope drainage.

6. Finish U-6: Magnesium float finish without local depressions or high points. Apply an expanded metal roller tamp finish with 1/4 inch deep depressions. Apply the roller tamp marks perpendicular to the direction of traffic.
3.17 CURING CONCRETE
A. Conform to ACI 308.
B. Select the appropriate curing methods, curing materials and compounds in response to climatic and site conditions occurring at the time of concrete placement. Take appropriate measures as described in ACI 305 and ACI 306 for protecting and curing concrete during hot and cold weather.
C. Do not use curing compound on surfaces which are to be coated in accordance with Section 09900, Painting and Coating, unless curing compound is completely removed by sand, grit or water blasting.

3.18 REPAIR OF DEFECTS
A. Do not repair defects until concrete has been inspected by the Engineer.
B. Repair surface defects that are smaller than one foot across in any direction and are less than 1/2 inch in depth by removing the honeycombed and other defective concrete down to sound concrete, make the edges perpendicular to the surface and at least 3/8 inch deep, thoroughly dampen the surface, work into the surface a bonding grout, fill the hole with mortar, match the finish on the adjacent concrete, and cure as specified.
C. Repair severe defects that are larger than surface defects but do not affect the structural integrity of the structure by removing the honeycombed and other defective concrete down to sound concrete, make the edges of the hole perpendicular to the surface, sand, grit or water blast the surface, coat the blasted surface with epoxy bonding compound, place nonshrink grout, match the finish on the adjacent concrete, and cure as specified.
D. If the defects affect the structural integrity of the structure or if patching does not satisfactorily restore the quality and appearance to the surface, remove and replace all affected areas.

3.19 REPAIR OF CRACKS
A. Repair cracks in concrete structures that are greater than 1/10 inch in width by cutting out a square edged and uniformly aligned joint 1/4 inch wide by 1/2 inch deep, preparing exposed surfaces of the joint, priming the joint, and applying polyurethane joint sealant.
B. If the crack affects the structural integrity or function of the element, remove and replace all affected areas.

3.20 SURFACES TO BE COATED
A. Apply surface coatings to finished concrete in accordance with Section 09820, Crystalline Waterproofing, and Section 09900, Painting and Coating.
B. Coat aluminum surfaces in contact with concrete per Section 09900, Painting and Coating, System No. 51.

3.21 USE OF CONCRETE ADMIXTURES
A. Concrete admixtures may be added at the Contractor’s option to control the set, effect water reduction, and increase workability. All labor, materials, and equipment to provide the admixture shall be at the Contractor’s expense. The use of an admixture shall be subject to acceptance by the Engineer. If the use of an admixture is producing an inferior end result, the Contractor shall discontinue use of the admixture.

3.22 USE OF FLY ASH
A. Fly ash is acceptable for use in the concrete mix for concrete structures, except water retaining structures. Typical water retaining structures include flow regulatory structures, reservoirs, weir structures, and other water retaining structures as shown on the Plans or as specified herein. Non-water containing structures, where the use of fly ash in the concrete mix is acceptable, include concrete valve vaults; cast-in-place portions of flow control and pump station buildings; and air release valve, air-vacuum valve, pump well, and blow-off structures.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes design, supply, and installation of precast concrete vaults and structures, complete with access hatches, manhole frames, covers, lifting inserts, and ladders, as shown on Plans and specified in this section.

B. Precast concrete vaults may be constructed as an alternative to cast-in-place vaults only at the locations shown on the Plans. Where a precast vault alternative is not indicted, the Contractor shall construct the vault using cast-in-place methods.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02200 Earthwork

B. Section 03000 General Concrete Construction

C. Section 05120 Structural Steel, Aluminum, and Miscellaneous Metalwork

D. Section 09820 Crystalline Waterproofing

E. Section 15100 Valves

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Concrete Institute
   504R-90 Guide to Joint Sealants for Concrete Structures.

B. American Society for Testing and Materials
   C150 Specification for Portland Cement.
   C387 Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
   C487 Specification for Precast Reinforced Concrete Manhole Sections.
   C858 Specification for Underground and Precast Concrete Utility Structures.

1.04 SUBMITTALS

A. Manufacturer's catalog data on precast concrete items. Show materials of construction by ASTM reference and grade.

B. Manufacturer's certification that vault design and manufacture comply with the referenced ASTM specifications (e.g., ASTM C857 and C858). Vault design calculation shall be signed by a California Registered Civil or Structural Engineer.

C. Manufacturer's laboratory test reports as required.

D. Detailed drawings showing complete information for fabrication and erection including, but not limited to:
1. Member dimensions and cross sections; location, size, and type of reinforcement, including additional reinforcement and lifting devices for handling and erection.

2. Erection procedures, sequence of erection, and required handling equipment.

3. Layout dimensions and identification of each precast unit corresponding to the sequence and procedure of installation.

4. Welded connections indicated by AWS standard symbols.

5. Details of connections, joints, accessories, and openings or inserts.

6. Details for watertight joints.

7. Location and details of anchorage devices.

8. Structural design calculations and analysis.

1.05 QUALITY ASSURANCE

A. The manufacturer shall demonstrate the capability to make and provide the specified quality products by attestation of the Prestressed Concrete Institute under the Plant Certification Program.

1.06 DELIVERY AND STORAGE

A. Store each unit in a manner that will prevent cracking, distortion, warping, straining, and other physical damage, and in a manner to keep marking visible.

B. Lift and support each unit only at designated lifting points and supporting points as shown on the Shop Drawings.

PART 2 - MATERIALS

2.01 PRECAST CONCRETE VAULTS

A. Precast concrete vaults shall comply with ASTM C858, except as modified herein.

B. Precast construction shall be of the rigid type and behave monolithically. Do not use panel-type vaults. Design loads shall be in accordance with ASTM C857. Traffic loads shall be designation A-16 per Table 1 with a 20 percent increase due to impact. Soil lateral loads shall be as determined by ASTM C857 or loadings specified in the project soils report, whichever is greater. Alternate design by the ultimate strength method shall include a load factor of 1.7 for lateral earth and 1.4 for hydrostatic pressures. Minimum wall thickness shall be eight inches. Two layers of reinforcing steel shall be required in wall and roof sections.

C. Necessary provisions shall be made in the design to accommodate additional stresses or loads which may be imposed during factory precasting, transporting, or erecting.

D. In the event of conflict between or among standards, the more stringent shall govern.

E. Each member or element shall be marked to indicate location in the structure, top surface, and date of fabrication.

F. Precast concrete vaults shall be manufactured by B&W Precast Construction, Inc., San Diego, California; or equal.
2.02 PRECAST CONCRETE RISERS
   A. Precast concrete grade rings and cones shall comply with ASTM C478, except that the minimum wall
      thickness shall be six inches. Provide interlocking keyways on rings and cones. Provide grade ring with
      cast in place inserts for the access hatch or manhole frame and cover. Provide watertight joints.

2.03 CONCRETE
   A. Concrete for the manhole base shall be Class A per Section 03000, General Concrete Construction.

2.04 SEALANTS AND GROUT
   A. Plastic sealing compound shall be SIKADUR 1A. Mortar shall comply with ASTM C387, Type S, or use
      grout complying with Section 03000, General Concrete Construction.

2.05 METALWORK
   A. Ladders, access hatches, manhole frames and covers shall conform to Section 05120, Structural Steel,
      Aluminum and Miscellaneous Metalwork.
   B. Valve box materials and installation shall conform to Section 15100, Valves.

PART 3 - EXECUTION

3.01 EXCAVATION AND BACKFILL AROUND VAULTS
   A. Perform excavation, backfill and compaction in accordance with Section 02200, Earthwork. Compact each
      lift of structural backfill all around vault before placing next lift.

3.02 VAULT BASE
   A. Form and pour cast-in-place concrete base in one monolithic pour.

3.03 INSTALLING VAULTS
   A. Set each precast concrete vault unit plumb.
   B. Install access hatches and manhole frames and covers per manufacturer's recommendations. Install the
      access hatches and manhole frames and covers to the finished elevations shown on the Plans, or as follows:
      1. In paved areas the top of cover shall be 0.05 feet above the paving surface.
      2. In shoulder areas the top of cover shall be 0.1 feet above the existing surface where the cover is
         located outside of the traveled way.

3.04 SEALING AND GROUTING
   A. Fill joints between precast sections per manufacturer's recommendation to produce a watertight joint. Dry
      pack interior of all joints to provide a smooth finish.

3.05 WATERPROOFING
   A. Apply crystalline waterproofing to the exterior surfaces of vaults after installation per Section 09820,
      Crystalline Waterproofing.

END OF SECTION
SECTION 04220 - REINFORCED HOLLOW CONCRETE MASONRY

PART 1 - GENERAL

1.01 DESCRIPTION
A. This section includes the materials, supply, and construction of reinforced hollow load-bearing concrete masonry.

1.02 RELATED WORK SPECIFIED ELSEWHERE
A. Section 03000 General Concrete Construction
B. Section 05120 Structural Steel, Aluminum, and Miscellaneous Metalwork

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS
A. Where a date is given for reference standards, that edition shall be used. Where no date is given for reference standards, the latest edition available on the date of Notice Inviting Bids shall be used.
B. American Society for Testing and Materials
   A615 Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   C90 Standard Specification for Loadbearing Concrete Masonry Units.
   C140 Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
   C144 Specification for Aggregate for Masonry Mortar.
   C260 Specification for Air Entraining Admixture for Concrete.
   C270 Specification for Mortar for Unit Masonry.
   C404 Specification for Aggregates for Masonry Grout.
   C476 Specification for Grout for Masonry.
   C780 Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
   C1142 Specification for Extended Life Mortar for Unit Masonry.
C. Uniform Building Code
   21-4 Standard for Hollow and Solid Load-Bearing Concrete Masonry Units.
   21-10 Standard for Joint Reinforcement for Masonry.
   21-14 Standard for Mortar Cement.
21-16 Standard for Field Tests Specimens for Mortar.


1.04 SUBMITTALS

A. Two samples of concrete masonry units including special shapes, joint reinforcement and jointing materials, to be used on project.

B. Manufacturer's catalog data on hollow load-bearing concrete masonry units. Show range of colors, texture, finishes and dimensions.

C. Information illustrating horizontal joint reinforcement and preformed joint materials proposed for use.

D. Mix design for concrete masonry units, mortar and grout, with laboratory three, seven and 28-day compressive strength tests, prior to the start of construction.

E. Method of placing and consolidating grout.

F. Report from a testing laboratory verifying that aggregate material conforms to the gradations specified for masonry units, mortar, fine and coarse grouts.

1.05 QUALITY ASSURANCE

A. Affidavit(s) from manufacturers that concrete masonry units comply with the referenced specifications and standards.

B. Concrete masonry units shall be produced by a company certified in the Quality Control Program of the California Concrete Masonry Technical Committee.

PART 2 -MATERIALS

2.01 CONCRETE MASONRY UNITS

A. The masonry units shall be hollow load-bearing concrete masonry units, of normal weight class, Type I moisture controlled, conforming to ASTM C90. Color of units and surface texture shall be as shown on the Plans. Exact tone will be selected by Engineer.

B. At the time of delivery to the job site, masonry units shall meet the moisture-content requirements, minimum thickness of face shells and webs, strength and absorption requirements as prescribed in Tables 1, 2 and 3 of ASTM C90.

C. Masonry units shall be sound and free from cracks, chipped edges, or other defects that would interfere with their proper setting or impair the strength or durability of the construction. Where used as the finished surface of exposed masonry walls, units shall be free from surface defects that would be noticeable and objectionable at a distance of 20 feet from the finished wall under diffused lighting. Provide special units for bond beams, sills, columns, and half blocks to hold cutting to a minimum.

D. Precast concrete sills shall be reinforced and have a smooth exterior finish.

E. Permissible variations in dimensions shall conform to Section 6 of ASTM C90 and Section 21.406 of UBC 21-4.
F. Sampling, testing and rejection shall conform to Sections 8 and 9 of ASTM C90.

2.02 MORTAR

A. Mortar for concrete masonry units shall be Type M per ASTM C270.

B. Mortar shall conform to the property specifications, 2500 psi in specified compressive strength at 28 days, 75 percent minimum in water retention and 12 percent maximum in air content, per requirements of Table 2, Sections 5 and 6.2 of ASTM C270.

C. Aggregates shall consist of natural sand or manufactured sand of grading and composition conforming to ASTM C144.

D. Cementitious materials and admixtures shall conform to Section 4 of ASTM C144. Where colored concrete masonry units are used, mortar shall be colored to match.

2.03 GROUT

A. Grout for use in the construction of concrete masonry structure shall be fine or coarse grout, conforming to ASTM C476.

B. Grout shall have a maximum slump of nine inches, plus or minus one inch, and a specified compressive strength of 2000 psi at 28 days.

C. Fine grout shall be manufactured with fine aggregates. Coarse grout shall be manufactured with a combination of coarse and fine aggregates. Coarse and fine aggregates shall conform to ASTM C404.

D. Cementitious materials, admixtures and pumping aids shall conform to Section 4 of ASTM C476.

E. Air-entraining admixtures shall conform to ASTM C260.

2.04 JOINTS

A. Jointing materials shall include, but not limited to, joint filler, backing tape, backer rod and joint sealant as specified in Section 03000, General Concrete Construction.

2.05 REINFORCEMENT

A. Reinforcing steel shall conform to ASTM A615, Grade 60.

B. Cold-drawn steel wire to be used as such or in fabricated form, for the reinforcement shall conform to Part II of UBC 21-10, Joint Reinforcement for Masonry.

C. Horizontal joint reinforcement shall consist of deformed longitudinal wires welded to cross wires, of configuration, size, tensile and weld shear strengths conforming to Part I of UBC 21-10.

D. Wall ties and anchors made from steel wire shall conform to UBC 21-10, Part II. Other steel wire and anchors shall conform to ASTM A36 and Section 05120, Structural Steel, Aluminum and Miscellaneous Metalwork. Connectors not fully embedded in mortar or grout shall either be corrosion resistant or galvanized.
PART 3 - EXECUTION

3.01 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Store masonry units above ground on level platforms which allow air circulation under stacked units. Cover and protect against wetting prior to use.

B. Deliver units on pallets or flat-bed barrows. Do not permit free discharge from conveyor or mortar trays.

C. All metal reinforcement shall be free from loose rust and other coatings that would inhibit reinforcing bond.

D. Cementitious materials and aggregates shall be stored in such a manner as to prevent deterioration or intrusion of foreign materials.

3.02 MIXING AND HANDLING MORTAR

A. For mortar mixed at job site, cementitious materials and aggregate shall be mixed for not less than five minutes or more than 10 minutes in a mechanical batch mixer with the maximum amount of water to produce a workable consistency. Mortar may be retempered by adding water as frequently as needed to restore the required consistency.

B. Mortar which has hardened or stiffened due to hydration of the cement shall not be used. In no case shall mortar be used beyond two and one-half hours after the initial mixing water has been added to the dry ingredients.

C. Ready-mixed mortar shall conform to ASTM C1142.

D. Hand mixing of small amounts of mortar may be permitted upon written approval from the Engineer outlining the hand mixing procedures.

3.03 MIXING AND HANDLING GROUT

A. Grout mixed at the job site shall be mixed for not less than five minutes or more than ten minutes in a mechanical mixer with sufficient water to bring the mixture to the desired consistency. Grout shall not be used beyond one and one-half hours after initial mixing.

B. Hand mixing may be permitted on small jobs upon written approval from the Engineer outlining the hand mixing procedures.

C. Grouting limitations shall conform to Table 21-C of UBC Chapter 21.

3.04 PLACING REINFORCEMENT

A. Fabrication, delivery and placing of steel reinforcement shall be in accordance with Section 03000, General Concrete Construction, and as specified herein.

B. Reinforcement shall be located as shown on the Plans and in accordance with the specifications. Foundation dowels shall be of same size and spacing as vertical wall bars, unless specifically noted otherwise.

C. Vertical reinforcement may be placed initially and the wall built up around it, providing reinforcing steel is tied to foundation dowels.

D. Reinforcement shall be secured against displacement prior to grouting by wire positioners or other suitable devices as intervals not exceeding 200 diameters of the vertical bar.
E. Where high-lift, full-height grouting is employed, place full length vertical reinforcing. No splices are permitted in vertical reinforcing, unless indicated on the Plans.

F. Securely hold vertical reinforcement in high-lift grouting at top and bottom and at 192 bar diameters.

G. Place horizontal reinforcing in special bond beam or other channel units. Lap splices by 50 diameters and securely tie. Splices are not allowed in lintels.

H. Wire joint reinforcement used as principal reinforcement shall be in accordance with UBC Section 2104.8

I. Tolerances for the placement of reinforcement in walls and flexural elements shall be in accordance with UBC Section 2104.5

3.05 PLACING MASONRY UNITS

A. Place masonry units in accordance with UBC Section 2104.4. Mortar shall be sufficiently plastic and units placed with sufficient pressure to extrude mortar from the joint and produce a tight joint.

B. The initial bed joint thickness shall not be less than 1/4 inch or more than one inch. When the air temperature is below 40 degrees F, heaters are required for curing. If the air temperature is above 95 degrees F, provide shade over the mortar construction.

C. Adjust masonry unit to final position while mortar is soft and plastic. If units are displaced after mortar has stiffened, remove, clean joints and units of mortar, and relay with fresh mortar. When joining fresh masonry to set or partially set masonry construction, clean exposed surfaces of set masonry and remove loose mortar prior to laying new masonry.

D. Maximum height of masonry laid prior to low-lift grouting shall be five feet. Where high-lift grouting is used, masonry may be laid full height of walls. If height of masonry prior to any grouting exceeds five feet, provide cleanouts at base of wall at each cell. Cleanouts are to be inspected, sealed and braced before grouting.

E. Set anchor bolts to line and grade with proper projection prior to grouting.

3.06 BUILT-IN ITEMS

A. Position door frames, windows, vents, and other items to be built in the wall, and construct wall around them.

B. Install wall ties when brick facing is specified. Space ties 24 inches horizontally and 16 inches vertically with staggered lines.

C. Provide a strip of expended metal lath in the masonry mortar joints under all concrete-filled lintel blocks, spandrel blocks, and concrete beams that are poured on top of the hollow masonry units.

D. Install bond beam or lintel units with minimum eight inch bearing at each end. Reinforce units with horizontal steel bars as indicated on the Plans and extend bars a minimum of 40 diameters or 24 inches minimum beyond openings on each side. Fill all cores of bond beams with grout, vibrating the mix to fill cells completely and provide positive bond to reinforcing. Lay first course of masonry above lintel in full bed of mortar.

E. As masonry work progresses, bolt, sleeves, anchors, angles, flashings, wall plugs, and other accessories shall be inserted in concrete masonry walls and solidly grouted in place.

F. Masonry walls shall be temporarily shored and braced until the design lateral strength is reached to prevent collapse due to winds and other forces.
3.07 MORTAR JOINTS

A. Joints shall be straight, clean, with uniform thickness of 3/8 inch.

B. Joints exposed to view shall be tooled. Exposed exterior joints shall be cut flush, as mortar takes its initial set, tooled to provide a dense, smooth, concave joint. Joints to receive caulking shall be raked out 3/4 inch and left ready for caulking. Exposed interior joints shall be tooled flush.

C. Tooling shall be performed when mortar is partially set but still sufficiently plastic to bond. Tooling with a tool which compacts mortar, pressing excess mortar out rather than dragging it out.

D. Joints which are not tight at time of tooling shall be raked out, pointed, and then tooled.

E. Concealed joints shall be struck flush with no further treatment required.

3.08 CONTROL AND EXPANSION JOINTS

A. Install control and expansion joints as shown on the Plans. Unless indicated otherwise, provide 3/8 inch vertical control joints in concrete masonry walls, spacing no more than 25 feet apart. Form joints with square end masonry units.

B. Install jointing materials, including joint filler, backer rod or backing tape and joint sealant, in accordance with Section 03000, General Concrete Construction.

3.09 POINTING AND CLEANING

A. At final completion of unit masonry work, fill any remaining holes in joints and tool. Do not fill weep holes. Cut out and repoint defective joints. Dry brush masonry surface after mortar has set, at end of each day's work, and after final pointing. Leave work and surrounding surfaces clean and free of mortar spots and droppings.

B. Do not saturate masonry wall with water for curing, but where the atmosphere is dry, dampen the surfaces with a very light fog spray during a curing period for the mortar of three days.

C. Clean exposed interior and exterior masonry surfaces by whip light sandblasting to remove all stains and other imperfections, as requested by the Engineer.

D. Exposed masonry surfaces of openings and windows, such as sills, heads, and jambs, shall be finish block surfaces, not formed surfaces, unless shown or specified otherwise. Closed bottom bond beams shall be used at heads and sills.

3.10 PLACING GROUT

A. Grouted masonry shall be constructed in such manner that all elements of the masonry act together as a structural element. Placing grout shall be in accordance with UBC Chapter 21, Section 2104.6.

B. Grout type, maximum height of grout pour, and minimum clear areas within grout spaces and cells shall conform to Table 21-C of UBC Chapter 21.

C. Grout shall be placed as soon as possible after mortar has cured to reduce shrinkage cracking of vertical joints. Grouting of any section of wall shall be completed in one day with no interruption greater than one hour.

D. Between grout pours, horizontal construction joints shall be formed by stopping the grout pour 1-1/2 inch below the mortar joint, except at a bond beam where the pour shall be stopped 1/2 inch below the top of the joint.
masonry. When grouting is stopped for more than 1 hour, horizontal joints shall be formed by stopping the pour 1/2 inch below the top of the uppermost unit. Horizontal steel shall be fully embedded by grout in an interrupted pour.

E. Cleanouts shall be provided for all grout pours over five feet in height. Where required, cleanouts shall be provided in the bottom course of every vertical bar but not be spaced at less than 32 inches for solidly grouted masonry. Cleanouts shall be sealed after inspection and before grouting.

F. Masonry units may be laid to the full height of the grout pour and grout shall be placed in a continuous pour in grout lifts not exceeding six feet.

G. Vertical alignment shall be maintained in cell to provide a clear, unobstructed, continuous vertical cell measuring not less than two inches by three inches.

H. All cells shall be filled solid. Consolidate grout by mechanical vibration and reconsolidate after excess water is absorbed into masonry units, but before plasticity is lost (five to ten minutes after grouting).

I. Beams shall be grouted over openings in one continuous operation.

J. Fill spaces around door frames and other built-in items.

K. Immediately wash spilled grout from surfaces of masonry units. Grout and mortar shall not be allowed to dry on face of exposed masonry.

3.11 FIELD TESTING

A. Compliance with the requirements for the specified compressive strength of concrete masonry shall be in accordance with either the masonry prism testing, the masonry prism test record or the unit strength method, as prescribed in UBC Section 2105.

B. When required, masonry units shall be tested for compliance with the compressive strength prescribed in Table 21-D of UBC Chapter 21.

C. Grout testing, when required, shall conform to UBC 21-18. Test the specimens for compressive strength, in a damp condition, in accordance with applicable requirements of UBC 21-17.

D. Mortar testing, when required, shall conform to UBC 21-16 and ASTM C780-91.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section describes materials, fabrication, and installation of structural steel, structural aluminum, steel tubing, aluminum tubing, connecting bolts, drilled anchors, capsule anchors, eyebolts, handrail, stainless-steel fasteners, aluminum sheet, grating and floor plates, ladders, access hatches, stair nosings, and stair treads.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03000  General Concrete Construction
B. Section 03480  Precast Concrete Vaults
C. Section 09900  Painting and Coating
D. Section 15100  Valves

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Association of State Highway and Transportation Officials
B. American Society for Testing and Materials
   A36  Specification for Structural Steel.
   A53  Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
   A153 Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   A193 Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
   A194 Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure and High-Temperature Service.
   A307 Specification for Carbon Steel Bolts and Studs, 6,000-psi Tensile.
   A500 Specification for Cold Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
   A501 Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
   B429 Specification for Aluminum Alloy Extended Structural Pipe and Tube.
   F436 Specification for Hardened Steel Washers.
F593 Specification for Stainless Steel Bolts.
F594 Specification for Stainless Steel Nuts.

C. American Water Works Association

D. American Welding Society
A5.5 Specification for Low Alloy Steel Covered Arc Welding Electrodes.
D1.1 Structural Welding Code Steel, latest edition.

1.04 DESIGN CRITERIA


B. Handrails, Walkways, Ladders, Personnel Platforms: OSHA, California State Safety Standards or UBC, whichever is more stringent.

C. Grating, Floor Plates, and Miscellaneous Cover Plates: Design live load of 150 psf, maximum deflection of 1/240 of span.

1.05 SUBMITTALS

A. Shop Drawings of fabricated items, such as stairs, grating, bolts, handrail, ladders, concrete anchors, and access hatches. Show dimensions and reference materials of construction by ASTM designation and grade.

B. Weld procedure specifications, procedure qualification records including all destructive and nondestructive test results and welding bead profiles as required along with individual welder qualification certificates. The Engineer shall be present during qualification of weld procedure.

PART 2 - MATERIALS

2.01 STRUCTURAL STEEL SECTIONS

A. Material for all-purpose bolted or welded construction shall conform to ASTM A36.

2.02 STRUCTURAL ALUMINUM

A. Structural aluminum shall conform to ASTM B429 and B308.

2.03 BOLTS

A. Steel anchor bolts shall conform to ASTM A307. Anchor bolts shall be 5/8-inch minimum diameter unless shown otherwise. Steel anchor bolts shall be hot-dipped galvanized per ASTM A153, unless shown otherwise.

B. All connection bolts and I-bolts shall be stainless steel.

C. Provide self-locking nuts or lockwashers and plain nuts where shown on Plans.

D. Provide galvanized bolts where shown on Plans. Galvanizing shall be by the hot-dipped process per ASTM A153.
E. Stainless-steel bolts shall be ASTM A193, Grade B8M, Class 2, or ASTM F593, Type 316, Condition SH. Nuts shall be ASTM A194, Grade 8M, or ASTM F594, Type 316, Condition SH. Use ASTM A193 bolts with ASTM A194 nuts; use ASTM F593 bolts with ASTM F594 nuts. Provide a washer under each nut and under each bolthead. Washers shall be of the same material as the nuts.

F. Contractor shall certify that the bolts and nuts have been proof tested.

2.04 BEVELED WASHERS

A. Washers for American Standard beams and channels shall be square or rectangular, tapered in thickness, smooth, hot-dipped galvanized, and conforming to ASTM F436.

2.05 HANDRAILS

A. Steel handrails shall be standard weight (Schedule 40), one and a half-inch steel pipe, hot-dipped galvanized, conforming to ASTM A53.

2.06 STEEL HANDRAIL SAFETY CHAINS

A. Handrail safety chains shall be cadmium-plated steel. Chains shall be straight link style, 3/16 inch in diameter, with at least 12 links per foot and with snap hooks at each end. Snap hooks shall be cadmium-plated boat type. Provide two chains four-inches longer than the access opening.

2.07 STRUCTURAL STEEL TUBING

A. Conform to ASTM A500 or A501.

2.08 STAINLESS STEEL PLATE AND MEMBERS

A. Except where otherwise specified, stainless-steel plate and members shall be Type 304, ASTM A167.

2.09 WELDING ELECTRODES

A. Welding electrodes for structural steel shall conform to AWS A5.5. Use electrodes in the E-70 series.

B. Welding electrode for aluminum shall be 4043 filler metal.

C. Use Type 347 electrode for stainless steel.

2.10 GRATING

A. Grating shall be aluminum, unless indicated otherwise on the Plans. Steel grating shall be hot-dipped galvanized after fabrication. Main bars shall be of the thickness and of the depth indicated on the Plans.

2.11 CHECKERED COVER PLATES

A. Checkered cover plates shall be steel. Provide U-bolt lifting handles located at opposite ends on each removable section. Steel plates, including angle edgings, support angles, and lifting handles, shall be galvanized after fabrication.

2.12 FRAMES AND SUPPORTS FOR GRATING AND CHECKERED PLATES

A. Fabricated frames and supports for grating shall be aluminum, unless otherwise indicated on the Plans. Fabricated frames and supports for checkered plates shall be steel, unless otherwise indicated on the Plans. Steel frames and supports shall be hot-dipped galvanized after fabrication. Corners of embedded angle frames shall be mitered and welded with the welds ground smooth.
2.13 LADDERS

A. Fabricate ladders as shown on the Plans. Ladders shall be of carbon steel, hot-dipped galvanized after fabrication.

B. Install a telescoping tubular safety post on all ladders in street type structures. The safety post shall be manufactured of high strength steel with telescoping tubular section that locks automatically when fully extended. Upward and downward movement shall be controlled by a stainless steel spring balancing mechanism. All connecting bolts shall be stainless steel per Part 2.02 (E). All other members shall be hot dip galvanized. Safety post shall be Bilco LadderUp Model 2, or equal.

2.14 DRILLED ANCHORS

A. Unless otherwise indicated on the Plans, drilled anchors shall be Type 316 stainless steel wedge anchors as manufactured by Phillips Drill Company, Hilti, or equal. Minimum size for pipe hangers NPS six inches and smaller shall be 3/8 inch minimum; size for all other applications shall be 5/8 inch.

2.15 ACCESS HATCHES

A. Access hatches for right of way type structures shall be steel or aluminum construction, single or double leaf, channel frame, spring assisted access hatch, sized as shown on the Plans, and conforming to the following:

1. The channel frame shall be 1/4 inch thick formed into a 3-1/2 inch wide by three-inch deep gutter all around. Aluminum frames shall have a bituminous coating on areas in contact with concrete. Provide an aluminum skirt to accommodate slab thickness. Provide a 1-1/2 inch drainage coupling located at the front right hand corner of the channel frame. Provide an anchor flange around the perimeter. A screen or perforated cap shall be attached to the exposed end of the drainage coupling.

2. The hatch leaf shall be 1/4-inch steel or aluminum diamond pattern plate to withstand a live load of 300 psf. The hatch leaf shall have a spring assisted lifting mechanism to provide a smooth controlled door operation throughout the entire arc of opening and closing, prevent the door from slamming closed and allow the hatch to be opened using a maximum 20-pound Pull. The hatch leaf shall open to 90 degrees and lock automatically in that position. A vinyl grip handle shall be provided on the inside to release the hatch leaf from its closed position. The hatch leaf shall be equipped with a lifting handle that lays flush with the surface.

3. Access hatches shall have two recessed penta-head hold down bolts for single leaf doors and four penta-head recessed bolts for double leaf doors. The penta-head bolts shall be pinned to the door allowing the door to be opened but keeping the bolts from being removed. The penta-head bolts shall be made of the same material as the blocks that are attached to the access hatch. The hatch shall have a recessed tamper-proof hasp covered by a hinged lid flush with the surface. The recessed hasp box shall be sized 2-3/4 inches by 5-1/4 inches by 2-1/2 inches to be able to accommodate a number 5 Master Lock.

4. A plate with the letters “SDCWA” cast shall be attached to the hatch leaf. The letters shall be raised block, four inches tall, 1/4-inch in height and 1/4 inch thick.

5. Steel hatches and frames shall be hot-dipped galvanized after fabrication per ASTM A123. All hardware on steel and aluminum doors shall be stainless steel. The manufacturer shall supply a five-year warranty against defects in material or workmanship. Access hatches shall be Bilco Type J or JD, U.S. Foundry Type TPS or TPD, or equal.

6. For double leaf hatches, the hatch handle shall be on the ladder side of the structure so that access may be gained by opening only one leaf. Provide safety chain opposite the ladder side on double leaf hatches. Provide safety chains on both sides of double leaf hatches where ladder access is not provided.
B. Access openings for street type structures shall conform to Manhole Frames and Covers as specified below.

2.16 MANHOLE FRAMES AND COVERS

A. Street-type manhole frames and covers shall be made of gray iron castings conforming to ASTM A48, Class 35. Castings shall be smooth, clean, and free from blisters, blowholes, and shrinkage. Frames and covers shall be heavy duty, traffic type to support AASHTO-H20 loading. Provide circular or rectangular manhole frames and covers with clear opening sizes as shown on the Plans. The cover shall seat firmly into the frame without rocking.

B. Grind or otherwise finish each cover so that it will fit in its frame without rocking. Frames and covers shall be matchmarked in sets before shipping to the site.

C. Covers for manholes shall have the letters "SDCWA" cast thereon in raised block letters, three inch tall, 1/4-inch thick and 1/4 inch in height. Do not apply any other lettering. Manhole covers shall have blind lifting pockets and shall be provided with stainless steel bolt down screws.

D. Circular manhole frame and cover shall be South Bay Foundry SBF 1322, Neenah R-1741-F with R-1090 deep gusset inner lid, Alhambra Foundry A1518, or equal. Rectangular manhole frame and cover shall be split cover by Alhambra Foundry A1430, A1433, A1434, or equal.

E. Before leaving the foundry, clean castings and subject them to a hammer inspection. Then dip castings twice in a preparation of asphalt or coal tar and oil applied at a temperature of not less than 290 degrees F, nor more than 310 degrees F.

2.17 PIPELINE ANCHOR RING

A. Anchor rings shall be sized as shown in AWWA Manual M-11.

2.18 EMBEDDED METALWORK

A. Metalwork such as sill angles, post sleeve, etc., which are to be embedded in concrete shall be galvanized, unless noted otherwise on the Plans. Corners shall be mitered, and exposed edges and welds shall be ground smooth prior to galvanizing.

2.19 EMBEDDED EYEBOLTS

A. Eyebolts shall be of the welded-eye type, carbon steel.

PART 3 - EXECUTION

3.01 STORAGE OF MATERIALS

A. Store structural material, either plain or fabricated, above ground on platforms, skids, or other supports. Keep material free from dirt, grease, and other foreign matter and protect from corrosion.

3.02 FABRICATION AND ERECTION

A. Fabricate miscellaneous metal items to straight lines and true curves. Do not leave burrs or deformations when drilling and punching. Continuously weld permanent connections along the entire area of contact. Exposed work shall have a smooth finish with welds ground smooth. Joints shall have a close fit with corner joints coped or mitered and shall be in true alignment. Unless specifically indicated on the Plans, do not provide twists, or open joints in any finished member nor any projecting edges or corners at intersections. Conceal fastenings wherever possible. Built-up parts shall be free of warp. Exposed ends and edges of metal shall be slightly rounded. All boltholes shall be 1/8 inch in diameter larger than bolt size. Measure cast-in-place bolt locations in the field before drilling companion holes in structural steel beam or assembly.
B. Clean the surfaces of metalwork to be in contact with concrete of rust, dirt, grease, and other foreign substances before placing concrete.

C. Set embedded metalwork accurately in position when concrete is placed and support it rigidly to prevent displacement or undue vibration during or after the placement of concrete. Unless otherwise specified, where metalwork is to be installed in recesses in formed concrete, said recesses shall be made, metalwork installed, and recesses filled with dry-pack mortar in conformance with Section 03000, General Concrete Construction.

D. Field measure existing steel or concrete structures where necessary to ensure proper fabrication fit-up of new steel products.

3.03 GALVANIZING

A. Zinc coating for plates, bolts, anchor bolts, and threaded parts shall be in accordance with ASTM A153. Provide zinc coated structural steel, pipe, and tubing in accordance with ASTM A123.

3.04 WELDING

A. Perform welding on steel by the Shielded Metal Arc Welding process, conforming to the AWS Structural Welding Code D1.1.

B. Perform welding on aluminum by the Gas Metal Arc or Gas Tungsten Arc process, per the AWS Welding Handbook.

C. Provide a minimum of two weld passes for welds in excess of 5/16 inch thickness.

D. Produce weld uniform in width and size throughout its length with each layer of weldment smooth; free of slag, cracks, pinholes, and undercuttings; and completely fused to the adjacent weld beads and base metal. Avoid irregular surface, nonuniform bead pattern, and high crown. Form fillet welds of the indicated size of uniform height and fully penetrating. Accomplish repair, chipping, and grinding of welds in a manner that will not gouge, groove, or reduce the base metal thickness.

3.05 GRATING, FLOOR PLATES, AND MISCELLANEOUS COVER PLATES

A. Grating, floor plates, and miscellaneous cover plates shall be as detailed on the Plans or, if not detailed, shall be designed as specified herein. No individual piece of grating, floor plate, or miscellaneous cover plate shall weigh more than 80 pounds. Length of individual pieces shall not exceed one and one-half times the width, unless limited by the installation.

B. Field measure grating and cover plates for proper cutouts and size.

C. Grating shall be completely banded. For pipe and conduits (including electrical conduit) larger than one-inch diameter penetrating grating, cut and band grating before galvanizing.

D. Set seat angles for grating so that the grating will be flush with the floor. Maintain the grating and floor plates flush with the floor. Provide galvanized steel seat angles and anchors as indicated on the Plans.

3.06 INSTALLING HANDRAILS

A. Provide handrail components to complete the installation for the various types of handrail.

3.07 INSTALLING LADDERS

A. Mount ladders to provide not less than seven inches of toe clearance from the inside of rungs or steps to the nearest permanent object between the ladder mounts and the inside of the rungs or steps.
3.08 INSTALLING ACCESS HATCHES, MANHOLE FRAMES, AND COVERS
   A. Conform to Section 03480, Precast Concrete Vaults.

3.09 BOLTING
   A. Drive bolts accurately into the holes without damaging the thread. Protect bolthead from damage during driving. Bolthead and nuts shall rest squarely against the metal. Where bolts are to be used on beveled surfaces having slopes greater than one in 20 with a plane normal to the bolt axis, provide beveled washers to give full bearing to the head or nut.

   B. Bolts shall be of such length that not less than 1/4 inch nor more than 1/2 inch shall project above the nut in tightened position. Draw bolthead and nuts tight against the work. Tap bolthead with a hammer while the nut is being tightened. After final tightening, lock the nuts.

3.10 INSTALLING ANCHOR BOLTS
   A. Preset bolts and anchors by the use of templates. For mechanical equipment (pumps, compressors, blowers), do not use concrete anchors set in holes drilled in the concrete after the concrete is placed.

   B. For static items, use preset anchor bolts or drilled wedge anchors as shown on the Plans.

   C. After anchor bolts have been embedded, protect their threads by applying grease and by having the nuts screwed on until the time of installation of the equipment or metalwork.

3.11 CONTROL OF FLAME CUTTING
   A. Do not use a gas-cutting torch in the field for correcting fabrication errors on any member in structural framing. Use a gas-cutting torch only on minor members when the member is not under stress.

3.12 REPAIR OF GALVANIZED SURFACES
   A. Repair or replace metal with damaged galvanized surfaces. Accomplish repair of galvanized surfaces by use of DRYGALV as manufactured by the American Solder and Flux Company; Cold Galvanizing Repair Compound as manufactured by Rust-Oleum; or equal. Apply in accordance with the manufacturer's instructions.

3.13 CORROSION PROTECTION
   A. Coat aluminum surfaces to be embedded or which are in contact with concrete or masonry, per Section 09900, Painting and Coating, System No. 51, before installation. Allow the paint to dry before the aluminum is placed in contact with the concrete.

   B. Where aluminum surfaces come in contact with dissimilar metals, keep the dissimilar metallic surfaces from direct contact by use of neoprene gaskets or washers.

   C. Coat nongalvanized structural steel surfaces per Section 09900, Painting and Coating, System No. 10 or System No. 11. Apply prime coat in the shop prior to shipping to the site. Apply intermediate and finish coats after erection, except surfaces that will be inaccessible for coating after erection or assembly shall be finish coated prior to erection or assembly. Color of finish coat shall be determined by the Engineer.

   D. Coat galvanized pipe supports per Section 09900, Painting and Coating, System No. 52. Color of finish coat shall match adjacent piping.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes materials and installation of crystalline waterproofing for concrete surfaces.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03000 General Concrete Construction
B. Section 03480 Precast Concrete Vaults
C. Section 09900 Painting and Coating

1.03 SUBMITTALS

A. Manufacturer's specifications, installation instructions, and general recommendations for the use of the waterproofing materials.
B. Certified test data for each material showing compliance with the specified requirements.

1.04 QUALITY CONTROL

A. Performance Criteria: Install waterproofing materials so that the completed work provides an impermeable barrier to withstand prevailing water pressure.
B. Qualification of Manufacturers: Provide only products of manufacturers with at least five years of successful experience in supplying the principal materials for the required work.
C. Warranty: The Contractor shall warrant that all surfaces treated with crystalline waterproofing materials shall be free from water penetrations resulting from defective workmanship or materials for a period of five years from the date of recording of the Notice of Completion. If water penetration does occur within such period, the Contractor shall, at his sole expense, repair, replace, or correct such defective workmanship or materials.

PART 2 - MATERIALS

2.01 CRYSTALLINE WATERPROOFING

A. Crystalline waterproofing shall be a cementitious coating containing components which will diffuse into the concrete by water, react with free lime, and create an impervious, waterproof, calcified barrier in the substrate. Technical requirements:
   - Permeability \(2.6 \times 10^{-8}\) cm/sec (2 coats) minimum per Army C.E. CRD-C 48-55 or CRD-6 48-73
   - Compatibility Produce no degradation of substrate
B. Crystalline waterproofing shall be XYPEX, HEY'DI K-11 by Tamms Industries, or equal.

PART 3 - EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in their original sealed packages clearly marked with the brand and manufacturer's name. Store under cover in a dry, protected place.
3.02 SURFACE PREPARATION

A. Do not treat concrete surfaces with chemical hardeners or curing agents prior to the application of waterproofing.

B. Examine surfaces to be waterproofed for form tie holes and structural defects, such as honeycombing, rock pockets, faulty construction joints, cracks, etc. Repair these areas in accordance with Section 03000, General Concrete Construction.

C. Concrete surfaces shall have an open capillary system to provide tooth and suction and shall be clean, free from scale, form oil, laitance, curing compounds, and any other foreign matter. Lightly sandblast, water blast, or acid etch with muriatic acid (15 to 20 percent) to provide a clean absorbent surface. Saturate surfaces to be acid etched with water prior to application of acid. Vertical surfaces may have a sacked finish. Do not apply a slurry coat of waterproofing materials to horizontal concrete deck surfaces which are less than 20 hours old.

D. Use light sandblasting or etching to remove the surface glaze of dense or steel troweled concrete.

E. Abrasive clean and wash construction joints.

3.03 APPLICATION

A. After completing repairs, apply a two-coat system to the concrete surfaces to be treated. Apply after curing and finishes are completed. Application of waterproofing and any paint topcoatings shall conform to manufacturer's recommended application procedures.

B. The Contractor shall have the manufacturer's representative advise and/or supervise the waterproofing application in person.

C. Apply crystalline waterproofing material to concrete which has been thoroughly saturated with clean water. Moisten surfaces to be treated prior to application. Remove free water prior to application of waterproofing material.

D. Apply crystalline waterproofing to the exterior surfaces of vault walls and precast concrete manholes which will be in contact with earth, and to joints of all precast concrete sections as shown on the Plans. Coat walls from bottom of wall to one foot above finished grade. Color of exterior surfaces shall be gray.

E. Apply second coat when the first coat has reached an initial set. Use light water spray on surfaces to be coated if rapid drying occurs.

3.04 CURING

A. Curing of the crystalline waterproofing shall be in accordance with manufacturer's recommendations.

3.05 BOND

A. Remove and apply fresh waterproofing in any area which has not developed full bond within 48 hours.

3.06 BACKFILLING

A. Do not backfill against structures for at least seven days after application of waterproofing.

B. Prior to backfilling, check treated surfaces for newly developed cracks. Repair cracks with XYPEX grout and cure surface for 48 hours before backfilling. Do not backfill with dry material until after complete cure of coating.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes materials and application of cement mortar linings for welded steel pipe applied at the pipe fabrication plant in accordance with AWWA C205, as modified below.

B. The finished inside diameter after lining shall be the nominal diameter shown.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02653 Steel Pipe

B. Section 02655 Installation of Pipe

C. Section 09872 Coal-Tar Coating

D. Section 09873 Cold-Applied Plastic Tape Coating

E. Section 09874 Fusion-Bonded Epoxy Lining and Coating

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Society for Testing and Materials

   A82 Specification for Steel Wire, Plain, for Concrete Reinforcement.

   A185 Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.

   C33 Specification for Concrete Aggregates.

   C40 Test method for Organic Impurities in Fine Aggregate for Concrete.

   C87 Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar.


   C150 Specification for Portland Cement.

B. American Water Works Association

   C205 Cement-Mortar Protective Lining and Coating for Steel Water Pipelines.

C. State of California, Department of Transportation, Manual of Test Volumes 1-2-3 (Standard Test Methods)

   Test 417 - Testing Soils and Waters for Sulfate Content

   Test 422 - Testing Soils and Waters for Chloride Content

1.04 QUALIFICATIONS OF MANUFACTURERS

A. Assign supervisors with at least two years continuous recent experience in the application of cement mortar linings for steel pipe and as specified herein.
B. Provide qualifications for cement mortar lining applicator as specified in Section 02653.

1.05 SUBMITTALS

A. Statement from the supplier that cement delivered to the work complies with the specifications.

B. Certification that sand complies with sieve analysis, ASTM C136; test of organic impurities in sands for concrete, ASTM C40; test of the effect of organic impurities in fine aggregate on the strength of mortar, ASTM C87.

C. Document and certify by pipe mark number that cement mortar lining thickness measurements meet the requirements as specified herein for each pipe, fitting, and pipe special.

PART 2 - MATERIALS

2.01 CEMENT

A. Cement shall be Type II, low alkali, conforming to the requirements of ASTM C150.

2.02 SAND

A. Provide sand conforming to ASTM C33 provided that 100 percent of the sand shall pass a No. 4 sieve for cement mortar coating applied directly in contact with a dielectric coating.

2.03 WATER

A. Water shall be free of organic materials and other impurities which might reduce the strength, durability or other quality of the cement mortar. Water shall have a pH of 7.0 to 9.0, a maximum chloride concentration of 500 mg/l (per Caltrans test method 422), and a maximum sulfate concentration of 500 mg/l (per Caltrans test method 417).

2.04 REINFORCEMENT FOR SPECIALS

A. Reinforcement for pipe diameters larger than 36 inches shall be Size W-1.2 welded wire fabric conforming to ASTM A185. Spacing shall be two inches center to center for longitudinal members and four inches center to center for transverse members (2x4-W12xW1.2). Crimped wire fabric reinforcement is not allowed. The wire need not be galvanized. Do not use excessively rusted fabric. Installed fabric shall be free from dirt and paint or other coating material.

PART 3 - EXECUTION

3.01 CEMENT MORTAR MIX

A. Cement mortar for lining the inside of the pipe shall be dry mixed and moistened with sufficient water to produce a dense, homogenous lining that will adhere firmly to the pipe surface, and shall be composed of not less than the following proportion by weight:

1. Spun mortar lining: one part cement to two parts sand.

2. Pneumatically applied mortar lining: one part cement to three parts sand.

B. Apply plant-applied cement mortar linings to the interior of the pipe in accordance with AWWA C205 as applicable, except as follows:

1. Apply, with pneumatic equipment, a mortar lining to welded steel pipe sections that cannot accommodate the pipelining machine.
2. Tack weld wire mesh reinforcement to certain steel fittings as specified below or where shown on the Plans, then apply mortar.

3. Select and process materials and place the mortar while the pipe is spun in a centrifugal machine.

3.02 REINFORCEMENT IN MORTAR LINING

A. Reinforce mortar linings for installation on flat surfaces, at abrupt angular changes in surfaces, or where lining is 3/4 inch or greater in thickness except where reinforcement is specifically indicated to be omitted.

B. Place fabric inside the sections so that the members lengthwise of the strip extend circumferentially around the inside surface, and attach to the steel surface by electric-arc tack welding at intervals not more than 16 inches apart, measured both along the axis of the section and circumferentially overlap sides and ends of the reinforcement one full mesh.

3.03 PNEUMATICALLY APPLIED MORTAR LINING

A. Interior surfaces of welded steel, cast-in-place lined pipe, and steel fittings, which cannot accommodate the lining machine shall receive a pneumatically applied mortar lining with a steel-troweled finish.

B. Pneumatically applied mortar lining in steel pipe and fittings shall have a thickness of 1/2 inch with a tolerance of plus 1/4 inch and minus zero, unless shown otherwise on the Plans. The thickness shall be tested at the center and four feet from the end of each length of pipe. A total of six gauge readings shall be taken at each location.

C. Apply the mortar lining in each pipe section or unit in a continuous operation without construction joints except that outlets and fittings of less than 36 inches in diameter may be lined with mortar by hand plastering. Following completion of mortar placement, screed or rod the surface and give a smooth steel trowel finish, free from waves, scratches, and distortions.

D. Damage to the lining resulting from falling rebound, from improper screeding and troweling, or from other operations or negligence on the Contractor’s part shall be cause for rejection.

3.04 APPLICATION OF SPUN MORTAR LINING

A. Unless otherwise shown on the Plans, the thickness of the lining in the pipe shall be 1/2-inch with a tolerance of plus 1/4 inch and minus zero. Manhole and outlet thimbles shall have a lining thickness of 3/8-inch with a tolerance of plus 1/8 inch and minus zero. The thickness shall be tested at the center and four feet from the end of each length of pipe. A total of six gauge readings shall be taken at each location.

B. Regardless of the amount of out-of-roundness if any section of pipe (when rotated in the spinning machine at the peripheral speed to be used for compaction) vibrates or exhibits any other departure from the smooth, concentric rotation necessary to produce a lining of the required quality, remove from the machine before the batch of mortar is deposited and adjust to cylindrical shape so that when returned to the spinning machine the required smooth, concentric rotation will be obtained.

3.05 BENDS, SHORTS AND SMALL FITTINGS

A. Line the interior surfaces of shop-fabricated bends and short sections 30 inches or more in diameter with pneumatically applied mortar. Mortar lining of steel fittings having a diameter of less than 30 inches may be applied by hand plastering, provided that the methods used produce a lining substantially equivalent in quality to pneumatically applied mortar.

3.06 CURING OF LINING

A. Immediately after application of the cement mortar lining, the lining shall be accelerated cured, moisture cured, or cured by a combination of accelerated and moist curing, in accordance with AWWA C205.
3.07 MANHOLES AND OUTLETS

A. Where openings in the pipe shell for manholes, outlets, or other purposes are required, remove a sufficient quantity of the spun mortar lining to accommodate the welding of steelwork at the opening while the lining is in a sufficiently green condition to facilitate its separation from the steel plate surface. Cut the opening in the steel plate and then weld the manhole thimble and reinforcement collar or other steelwork in place. At all times during these operations, the spun mortar lining shall be kept continuously moist. After completion of the welding and of the testing for leakage, remove all damaged lining, prepare the interior surfaces, place or restore the lining in the pipe by the pneumatic method, line the manhole or outlet thimble with mortar by hand plastering, and promptly resume the required water spray cure of the lining.

3.08 PROTECTING LINED PIPE

A. Immediately after the mortar lining has been completed, place internal bracing at the uncoated ends of the pipe to prevent the maximum and minimum diameter at any point from deviating 1/2 percent of the nominal diameter and leave in place until stubs or bracing are placed in the pipe, except that braces may temporarily be removed when the pipe is placed in the coating machine and replaced immediately after removing the pipe from the coating machine. If required, add additional interior braces prior to the specified coating, but not until the lining has received the minimum cure. Where braces are placed on coated areas, provide sufficient bearing surface at the ends of the braces inside the pipe so no damage will be done to the mortar lining. After installation of the pipe, remove any damaged lining and replace it with new pneumatically applied mortar lining.

B. Provide a polyethylene or other suitable bulkhead on the ends of the pipe and on all openings to prevent drying out of the lining. All bulkheads must remain intact during shipping and storage until the pipe is installed. Failure to maintain bulkheads will be cause for rejection.

C. Cross-bracing shall be shop-applied in accordance with Section 02653, Steel Pipe.

3.09 STORAGE/HANDLING

A. Protect the pipe lining from damage during transportation and installation of the pipe, and restore any damaged portions of the lining to a condition equal to that specified herein for the original work. At the fabrication plant, use belt slings or padded forklifts to transport or handle lined pipe sections. In no event shall pipe be transported from the lining yard until after the mortar lining has attained an age of seven days.
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes materials and application of cement mortar coatings for welded steel pipe applied at the pipe fabrication plant in accordance with AWWA C205, as modified below.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02653 Steel Pipe
B. Section 02655 Installation of Pipe
C. Section 09872 Coal-Tar Coating
D. Section 09873 Cold-Applied Plastic Tape Coating
E. Section 09874 Fusion-Bonded Epoxy Lining and Coating

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Society for Testing and Materials
   A82 Specification for Steel Wire, Plain, for Concrete Reinforcement.
   A185 Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
   C33 Specification for Concrete Aggregates.
   C40 Test method for Organic Impurities in Fine Aggregate for Concrete.
   C87 Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar.
   C150 Specification for Portland Cement.
B. American Water Works Association
   C205 Cement-Mortar Protective Lining and Coating for Steel Water Pipelines.
   C203 Coal-Tar Protective Coatings and Lining for Steel Water Pipelines - Enamel and Tape - Hot Applied.
C. State of California, Department of Transportation, Manual of Test Volumes 1-2-3 (Standard Test Methods)
   Test 417 - Testing Soils and Waters for Sulfate Content.
   Test 422 - Testing Soils and Waters for Chloride Content.

1.04 QUALIFICATIONS OF MANUFACTURERS

A. Assign supervisors with at least two years continuous recent experience in the application of cement mortar lining coating for steel pipe and as specified herein.
B. Provide qualifications for cement mortar coating applicator as specified in Section 02653.

1.05 SUBMITTALS

A. Statement from the supplier that cement delivered to the work complies with the specifications.

B. Certification that sand complies with sieve analysis, ASTM C136; test of organic impurities in sands for concrete, ASTM C40; test of the effect of organic impurities in fine aggregate on the strength of mortar, ASTM C87.

C. Document and certify by pipe mark number that cement mortar lining thickness measurements meet the requirements as specified herein for each pipe, fitting, and pipe special.

PART 2 - MATERIALS

2.01 CEMENT

A. Cement shall be Type II, low alkali, conforming to the requirements of ASTM C150.

2.02 SAND

A. Provide sand conforming to ASTM C33 provided that 100 percent of the sand shall pass a No. 4 sieve for cement mortar coating applied directly in contact with a dielectric coating.

2.03 WATER

A. Water shall be free of organic materials and other impurities which might reduce the strength, durability or other quality of the cement mortar. Water shall have a pH of 7.0 to 9.0, a maximum chloride concentration of 500 mg/l (per Caltrans test method 422), and a maximum sulfate concentration of 500 mg/l (per Caltrans test method 417).

2.04 REINFORCEMENT

A. Reinforcement for pipe diameters larger than 36 inches shall be Size W-1.2 welded wire fabric conforming to ASTM A185. Spacing shall be two inches center to center for longitudinal members and four inches center to center for transverse members (2x4-W1.2xW1.2). Crimped wire fabric reinforcement is not allowed. The wire need not be galvanized. Do not use excessively rusted fabric. Installed fabric shall be free from dirt and paint or other coating material.

B. Steel wire conforming to ASTM A82 may be used as a reinforcement for mortar coatings for pipe diameter 36 inches or less, except for specials and fittings which by their shape are not suited for its use.

PART 3 - EXECUTION

3.01 CEMENT MORTAR COATING

A. Apply a one inch thick reinforced cement mortar coating in accordance with AWWA C205 where specified. The cement mortar coating shall consist of not more than 4-1/2 cubic feet of sand to one sack of cement (94 pounds).

B. Leave an uncoated three-inch holdback from the end of the cold-applied plastic tape to the cement mortar coating at each pipe end to permit field tape coating of the joints. Allow sufficient length of holdback for other pipe coatings to provide clearance for coating joints in the field.

C. Apply the mortar coating in a one station operation with no lapse of time between application of adjacent mortar coating layers so that no sloughing will occur at any time during or following its application. If, for any reason, it is necessary to interrupt mortar placement for a sufficient length of time, whereby the material takes a permanent set (i.e., a construction joint is formed), form a shoulder by shooting the mortar against a
backing strip, or cut back with a trowel or other suitable tool the irregular edges of the material last placed to a clean, unbroken surface perpendicular to the face to provide a suitable connection or construction joint between such material and the material to be subsequently placed. Do not shatter or disturb the material remaining in place nor disturb the embedded welded-wire fabric. Before placing fresh material against the surfaces of such joints, carefully clean and wet these surfaces to insure a good bond between the fresh material and that previously placed. Featheredged construction joints will not be permitted. As soon as the material has hardened sufficiently, in the opinion of the Engineer, thoroughly wet with water the exterior of the mortar coating and thereafter cure.

D. Place the wire reinforcement after application of a 3/8 inch thick layer of mortar over the pipe coating. The wire shall not be in contact with the pipe coating or the steel cylinder. Following the placement of wire reinforcement, moisten surface and apply a second layer of mortar 5/8 inch thick over the wire to bring the total thickness of the mortar to the specified thickness.

E. Provide suitable means for checking the thickness of the coating applied.

3.02 CURING OF MORTAR COATING

A. After the initial set has taken place, cure the mortar coating using the water-spray, steam, or sealing compound methods. Do not interchange methods without written approval from the Engineer.

1. Water-spray method. Begin water-spray curing method as soon as the pipe or special can be sprinkled with water without damage to the coating. Keep the coating continually moist by intermittent or continuous spray for a minimum of 96 hours. Use the water-spray method only when the minimum ambient temperature exceeds 40 degrees F at all times during the curing period. No credit will be allowed for any curing time during which the temperature drops below 50 degrees F.

2. Steam Curing Method. Begin the steam curing within four hours after completion of the coating operation. Keep the coating continually moist by intermittent or continuous spray until steam curing begins. Maintain the minimum relative humidity at 85 percent with a curing temperature not exceeding 90 degrees F for the first three hours. Increase the curing temperature to between 110 degrees F and 150 degrees F maintaining the minimum relative humidity at 85 percent for the next 20 hours. Do not exceed the maximum allowable temperature for dielectric coated pipe.

3. Sealing compound method. The sealing compound shall conform with Section 3000, General Concrete Construction. The mortar coating shall be kept continuously wet by means of an adequate water spray or sprinkling system during the interval of time elapsing before application of the sealing compound. When the sealing compound is dry, a dense coat of whitewash shall be applied thereon, except that whitewash will not be required on white-pigment compound. Whitewash material shall conform to the requirements of Section 2.7 of AWWA C203.

3.03 STORAGE/HANDLING

A. Protect the pipe coating from damage during transportation and installation of the pipe, and restore any damaged portions of the coating to a condition equal to that specified herein for the original work. At the fabrication plant use belt slings or padded forklifts to transport or handle the coated and/or lined pipe sections. In no event shall pipe be transported from the coating yard until after the exterior mortar coating has attained an age of seven days.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes materials and application of coal-tar coatings on steel pipe in accordance with AWWA C203, as modified herein.

B. Coal-tar coating shall consist of primer, coal-tar enamel, and a cement mortar coating.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02653 Steel Pipe
B. Section 02655 Installation of Pipe
C. Section 09871 Cement Mortar Coating
D. Section 09873 Cold-Applied Plastic Tape Coating
E. Section 09874 Fusion-Bonded Epoxy Lining and Coating

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Water Works Association

   C203 Coal-Tar Protective Coatings and Lining for Steel Water Pipelines - Enamel and Tape - Hot-Applied.

B. Steel Structures Painting Council

   SP-10 Near-White Blast Cleaning.

1.04 SUBMITTALS

A. Certification of test results and compatibility of physical and performance characteristics of each batch of primer, coal-tar enamel, glass-fiber mats, and felt outer wraps.

B. Certification of test results of physical and performance characteristics of each batch of primer and coal-tar tape. Submit results of electrical holiday tests conducted on finished applications.

1.05 QUALIFICATIONS OF MANUFACTURERS

A. Provide qualifications for coal-tar coating applicator as specified in Section 02653.

PART 2 - MATERIALS

2.01 PRIMER

A. Provide primer applied to the surface of steelwork from the same manufacturer supplying the coal-tar enamel.

2.02 COAL-TAR ENAMEL

A. The coal-tar enamel shall conform to the requirements set forth in Section 2.3 of AWWA C203 for type II enamel.
2.03 HOT-APPLIED COAL-TAR TAPES
   A. Conform to AWWA C203, 50 mil minimum in thickness, six inches wide, supported on inorganic non-
asbestos fibers.

PART 3 - EXECUTION

3.01 COAL-TAR ENAMEL COATING
   A. Apply a coal-tar primer and enamel coating conforming to the requirements of AWWA C203, except as modified herein.
   B. Prepare metal surfaces to be coated with coal-tar primer and enamel as specified in AWWA C203, Section 3.3, except as follows:
      1. Remove welding slag or scale by wire brushing, hammering, or other means prior to priming.
      2. Where pipe is shop cement mortar lined, apply the exterior coal-tar enamel coating after the pipe is lined with mortar.
   C. The thickness of enamel coating shall be 1/8 inch with tolerance of plus or minus 1/32 inch.
   D. Do not roll or support the enameled pipe on its enameled surface until thoroughly cooled and hardened. After completion of the testing operation, apply over the coal-tar enamel a reinforced cement mortar coating in accordance Section 09871, Cement Mortar Coating. Apply the cement mortar coating as soon as practical after the application of the coal-tar enamel coating.
   E. Hold back the cement mortar coating over the coal-tar enamel coating a sufficient length to provide clearance for coating joints in the field.

3.02 SPECIALS
   A. Coat specials with hot-applied coal-tar tape in accordance with AWWA C203 or with cold-applied plastic tape in accordance with Section 09873, Cold-Applied Plastic Tape Coating. Apply a reinforced cement mortar coat in accordance with Section 09871, Cement Mortar Coating, to specials. Hold back cement mortar coat three inches from end of tape.

3.03 ELECTRICAL INSPECTION
   A. After application of the coal-tar coating, and prior to application of the cement mortar coating, electrically test the coating by the method specified in Section 6 of AWWA C203. Repair all defects in coating.

3.04 COATING OF FIELD JOINTS
   A. Coat the exterior of field welded joints with hot-applied coal-tar tape in accordance with AWWA C203 or with tape in accordance with Section 09873, Cold-Applied Plastic Tape Coating. Apply the hot-applied coal-tar tape in two layers to produce a total thickness of 100 mils. Apply a cement mortar coating in accordance with Section 02655, Installation of Pipe, over the tape coating immediately following completion of taping inspection and testing.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION
A. This section includes materials and application of cold-applied plastic tapes on steel pipe in accordance with AWWA C209 and C214, as modified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE
A. Section 02653 Steel Pipe
B. Section 02655 Installation of Pipe
C. Section 09871 Cement Mortar Coating
D. Section 09872 Coal-Tar Coating
E. Section 09874 Fusion-Bonded Epoxy Lining and Coating

1.03 REFERENCE SPECIFICATION, CODES, AND STANDARDS
A. American Water Works Association
   C209 Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
   C214 Tape Coating Systems for the Exterior of Steel Water Pipelines.
B. National Association of Corrosion Engineers
   RP-02 High voltage Electrical Inspection of Pipeline Coatings Prior to Installation.
C. Steel Structures Painting Council
   SP-1 Solvent Cleaning.
   SP-6 Commercial Blast Cleaning.

1.04 QUALIFICATIONS OF MANUFACTURERS
A. Provide qualifications for cold-applied plastic tape coating applicator as specified in Section 02653.
B. Assign supervisors of tape coating operations with at least two years' continuous recent experience in the application of tape and coating systems for steel pipe.

1.05 SUBMITTALS
A. Certification of test results of physical and performance characteristics of each batch of primer and each tape material specified herein.
B. Tape application procedure approved by tape manufacturer.
C. Tape application method approved by tape manufacturer to minimize voids at weld seams.
D. The names and qualifications of the workers and supervisors to be employed on the coating operation a minimum of 14 days prior to the start of taping operations.

PART 2 - MATERIALS

2.01 COLD-APPLIED PLASTIC TAPE COATING

A. Provide cold-applied plastic tape coating in accordance with AWWA C209, AWWA C214, and as specified herein. Furnish plant and field applied primer and plastic tape, and plant and field applied repair tape by a single manufacturer. Meet or exceed the physical properties of tape materials for plant and field application criteria listed when tested in accordance with the methods described in AWWA C209 and AWWA C214, Section 4.12, "Coating System Tests."

B. The tape coating systems consist of an exterior cold-applied plastic tape on the bare metal surface of steel pipe with a cement mortar coating applied over the tape system. Tape coating systems are specified for:
   1. normal plant cold-applied tape;
   2. plant cold-applied tape for special sections, connections and fittings, and plant repairs of cold-applied tape; and
   3. field joint, field coated fittings and repair of field cold-applied tape.

2.02 PRIMER

A. Primer shall be comprised of 100 percent butyl rubber with resins for adhesion, cathodic disbonding and stress corrosion cracking inhibitors. The primer shall be Polyken #1039 primer with the following properties.
   1. Percent Solids: \(\geq 18\) percent
   2. Flash Point: \(>+109\) degrees F
   3. Viscosity: Thin syrup

2.03 STORAGE PRIMER

A. Storage primer on the exposed steel at the tape cutbacks shall be Polyken #924, with the following properties.
   1. Color: Black
   2. Base: Synthetic natural rubber and resin
   3. Solvent: Naphtha, toluene blend
   4. Total Solids: 19 percent by weight
   5. Viscosity: Thin syrup
   6. Flash Point: \(>+10\) degrees F

2.04 PLANT COLD-APPLIED PLASTIC TAPE SYSTEM

A. Anti-corrosion inner layer tape shall be Polyken #989, with the following properties:
   1. Tape Color: Black
   2. Backing: Consist of a minimum 98 percent blend of high and low density polyethylene with the remaining portion a blend of colorants and stabilizers.
   3. Adhesive: Consist of a 100 percent butyl based elastomers with resins for adhesion, cathodic disbonding, and long-term in-ground performance.
4. Thickness:
   a. Total thickness: 20 mil
   b. Backing: 9 mil
   c. Adhesive: 11 mil
   d. Tolerance: minus 5%, plus 10%.
5. Tensile Strength at Break: \( \geq 30 \text{ lb/in width} \)
6. Elongation at Break: \( \geq 200 \text{ percent} \)
7. Adhesion to Steel: \( \geq 100 \text{ oz/in width} \)
8. Adhesion to Primed Steel: \( \geq 300 \text{ oz/in width} \)
9. Adhesion to Backing: \( \geq 40 \text{ oz/in width} \)
10. Dielectric Strength: \( \geq 20 \text{ kV} \)
11. Insulation Resistance: \( 1 \times 10^{12} \text{ ohms} \)
12. Water Vapor Transmission: < \( 0.2 \text{gm/100in2/24 hr at 70 degrees F} \)
13. Cathodic Disbonding at 68 degrees F, for 30 days: \( 0.2 \text{ in2 (ASTM G8)} \)
14. Shear Resistance at 68 degrees F for four weeks: \( 0.2 \text{ mm/day} \)
15. Hydrolytic Stability, 200hrs at 98 degrees C H2O, Adhesion: > 150 oz/in
16. Thermal Stability, 2,000 hrs at 100 degrees C air, Adhesion: > 150 oz/in

B. First mechanical outer layer tape shall be Polyken # 955, with the following properties:

1. Tape Color: Gray
2. Thickness:
   a. Total thickness: 30 mil
   b. Backing: 25 mil
   c. Adhesive: 5 mil
   d. Tolerance: minus 5%, plus 10%.
3. Tensile Strength: \( \geq 45 \text{ lb/in width} \)
4. Elongation: \( \geq 200 \text{ percent} \)
5. Adhesion to Backing: 40 oz/in width
6. Water Vapor Transmission: < \( 0.2 \text{gm/100in2/24 hr at 70 degrees F} \)
7. Dielectric Strength: \( \geq 25 \text{ kV} \)

C. Second mechanical outer layer tape shall be Polyken #956 UV1 having UV protection properties as follows. Provide certification of UV protection.

1. Tape Color: White
2. Backing: Consist of a minimum 96 percent blend of high and low density polyethylene with the remaining portion a blend of colorants and stabilizers.
3. Adhesive: Consist of a 100 percent butyl based elastomer with resins for adhesion, and long term in-ground performance.
4. Thickness:
   a. Total thickness: 30 mil
b. Backing: 25 mil  
c. Adhesive: 5 mil  
d. Tolerance: minus 5%, plus 10%.

5. Tensile Strength: ≥ 55 lb/in width  
6. Elongation: ≥ 200 percent  
7. Adhesion to Backing: 60 oz/in width  
8. Water Vapor Transmission: < 0.2gm/100in2/24 hr at 70 degrees F  
9. Dielectric Strength: ≥ 25 kV

D. Total coating system shall be the Polyken YGIII system, with the following properties:

1. 100% Polyethylene based backings with colorants and stabilizers. 100% Butyl based elastomers.  
2. Adhesion to Steel: ≥ 100 oz/in  
3. Adhesion to Backing: ≥ 60 oz/in width  
4. Adhesion to Primed Steel: ≥ 300 oz/in  
5. Tensile Strength: ≥ 85 lb/in width  
6. Elongation: > 200%  
7. Dielectric Strength: ≥ 20 kV  
8. Insulation Resistance: 1 x 1012 ohms  
9. Water Vapor Transmission: = 0.25gm/100in2/24 hr at 70 degrees F  
10. Cathodic Disbonding at 68 degrees F for 30 days: 0.2 in2 (ASTM G8)  
11. Shear Resistance at 68 degrees F for 4 weeks: 0.2 mm/day  
13. Penetration: 11-15%

2.05 PLANT COLD-APPLIED PLASTIC TAPE COATINGS FOR SPECIAL SECTIONS, CONNECTIONS AND FITTINGS, AND PLANT REPAIR

A. Anti-corrosion inner layer shall be Polyken #932-50, with the following properties:

1. Backing: Consist of a minimum 96 percent blend of high and low density polyethylene with the remaining portion a blend of colorants and stabilizers.  
2. Adhesive: Consist of a 100 percent butyl based elastomer with resins for adhesion, cathodic disbonding, and long-term in-ground performance.  
3. Thickness:
   a. Total Thickness: 50 mil  
   b. Backing: 40 mil  
   c. Adhesive: 10 mil  
   d. Tolerance: minus 5%, plus 10%.
4. Tensile Strength: ≥ 25 lb/in width  
5. Elongation: ≥ 150%  
6. Adhesion to Steel: 225 oz/in width  
7. Adhesion to Backing: 60 oz/in width
8. Water Vapor Transmission: < 0.2gm/100in2/24 hr at 70 degrees F
9. Dielectric Strength: ≥ 28 kV

B. Mechanical layer outer tape for plant fittings and plant repair cold-applied plastic tape shall be Polyken #955, with the following properties:
1. Backing: Consist of a minimum 96 percent blend of high and low density polyethylene with the remaining portion a blend of colorants and stabilizers.
2. Adhesive: Consist of a 100 percent butyl based elastomer with resins for adhesion, and long term in-ground performance.
3. Thickness:
   a. Total thickness: 30 mil
   b. Backing: 25 mil
   c. Adhesive: 5 mil
   d. Tolerance: minus 5%, plus 10%
4. Tensile Strength: ≥ 45 lb/in width
5. Elongation: ≥ 200%
6. Adhesion to Backing: 40 oz/in width
7. Water Vapor Transmission: < 0.2gm/100in2/24 hr at 70 degrees F
8. Dielectric Strength: ≥ 25 kv

2.06 FIELD JOINT, FIELD COATED FITTINGS, AND FIELD REPAIR COLD-APPLIED PLASTIC TAPE
A. Joint filler tape to be Polyken #939, with the following properties:
1. Tape Color: Black
2. Thickness: 125 mil
3. Elongation: > 600%
4. Solids Content: 98% minimum
5. Penetration Hardness: 85-105 DMM (300 GM moving load)
6. Low Temperature Flexibility: No cracking when bent around a one-inch mandrel at minus 10 degrees F
7. Chemical Resistance: No visible deterioration after 30 days immersion in the following solutions: 5% Caustic Potash; 5% HCL, 5% H2SO4; Saturated HS

B. Field joint, field fitting, and field repair outer layer tape shall be Polyken #932-50, as specified herein.

PART 3 - EXECUTION
3.01 COLD-APPLIED PLASTIC TAPE COATING
A. Apply plastic tape coating in accordance with AWWA C214, C209, and as modified herein.

B. Certificate of Compliance: Prior to shipment of pipe, furnish a certificate of compliance stating that tape materials and work furnished hereunder will comply or have complied with the requirements of these specifications and AWWA C209 and C214. The certification shall be substantiated by the tape manufacturer's production quality control test results. The tape manufacturer shall supply test data on each batch used.
C. The tape manufacturer shall furnish a representative to provide assistance during the initial application of all tape materials to ensure proper installation.

1. Retain the tape manufacturer representative for a minimum of five consecutive working days of tape coating for each project heading. At the completion of the five-day period, the tape material manufacturer's representative shall meet with the Contractor and Engineer to review and update the tape coating operation plan. If, in the opinion of the Engineer, significant modifications to the tape coating operations are identified in the initial five day inspection period, retain the tape material manufacturer's representative for an additional length of time, as necessary to correct all deficiencies in the application of the tape coating system.

2. The tape manufacturer representative shall be retained by the Contractor for the duration of the work and shall respond to periodic field problems and questions from the Contractor and Engineer within a sufficient time period so as not to cause delay in the installation and backfill of pipe. Costs incurred for retention of the tape manufacturer's representative shall be borne by the Contractor.

3. Properly document any modifications to the pipe manufacturer's tape coating operation and submit within three working days to the Engineer in accordance with shop drawing submittal procedures.

3.02 STRAIGHT RUN PIPE APPLICATION

A. For straight run pipe, plant applied conditions, the cold-applied plastic tapes shall be a four layer system consisting of: (1) primer; (2) corrosion prevention tape (inner layer); (3) mechanical protective tape (first outer layer); and (4) mechanical protective tape (second outer layer).

B. Perform the entire coating operation as a one station operation where the pipe is supported at the ends in a manner which will permit the application of the primer, plastic tape, and cement mortar coating. Do not allow additional handling following the initial setup of the pipe section, from application of primer, tape coating, and cement mortar coating. No application involving rollers to support the pipe during the primer application, plastic tape, or cement mortar coating application will be permitted.

C. Perform the entire coating operation by experienced workers skilled in the application of cold-applied plastic tapes and cement mortar coating under qualified supervisors. The Engineer is to be immediately informed of any personnel changes associated with the pipe coating operation.

D. All equipment for blasting and application of the tape coating system shall be of such design and condition to comply with all the requirements of these specifications. Immediately repair or replace equipment which, in the opinion of the Engineer, does not produce the required results. Include equipment and a repair procedure for correcting defective tape application for use under this specification in the steel pipe fabrication plan. Make available for review a copy of this portion of the fabrication plan, and any updates, at the location of the coating operation, and a repair procedure for correcting defective tape application.

E. Remove the exterior weld bead along the entire exterior surface of the pipe. The exterior weld bead shall be flush with the exterior surface of the pipe with a tolerance of plus 1/64 inch. Removal of the weld bead is to be conducted in such a manner that no gouging or nicking of the plate surface will occur. This operation is to result in a smooth exterior surface with no ridges or valleys which may result in bridging or disbonding of the tape from the surface of the pipe.

F. Surface preparation shall conform to AWWA C214 and the following.

1. Bare pipe shall be clean of all foreign matter such as mud, mill lacquer, wax, coal tar, asphalt, oil, grease, or any contaminants. Wash off any chemical solutions used in cutting or welding with hot water and allow the surface to dry. Remove welding slag or scale from all welds by wire-brushing, hammering, or other satisfactory means. Remove welding splash globules prior to priming.

2. Prior to blast cleaning, inspect surfaces and, if required, preclean in accordance with the requirements of SSPC SP-1, Solvent Cleaning, to remove oil, grease, and all foreign deposits. Remove visible oil and grease spots by solvent wiping. Use only approved solvents that do not leave any residue.
Include in the manufacturer's fabrication plan the cleaning solvent applications procedure and safety precautions. Preheating to remove oil, grease, and mill scale will be permitted; provided, that the pipe is to be cement mortar lined in the field; and provided, all pipe is preheated in a uniform manner to avoid distortion. Do not exceed preheat temperatures of 500 degrees Fahrenheit.

3. Use on all affected steel-plate work, suitable and effective measures for eliminating the inclusion of gas forming elements, or other detrimental conditions, in any of the shop or field welds which results in any condition found to be detrimental to the successful application and bonding of primer, plastic tape, and cement mortar coating. Said measures to include time-curing the pipe sufficiently, thoroughly neutralizing the gas forming elements, or other approved treatment.

G. Blast cleaning shall conform to AWWA C214 and the following.

1. Blast the pipe surface using a commercially available shot grit mixture to achieve a prepared surface equal to that which is specified in SSPC SP-6, Commercial Blast Cleaning.

2. For plant mortar-lined pipe, perform blast cleaning of said exterior surfaces after the initial curing of the spun mortar lining. Perform the exterior blast cleaning in such a manner as not to endanger the mortar lining in the pipe. Completely remove corrosion and foreign substances from the exterior of the pipe in the blastcleaning operation, and apply primer immediately after completion of blast cleaning.

3. The shot grit mixture shall not exceed 40 percent shot to 60 percent grit. The shot grit mixture is to be determined prior to the start of blast cleaning operations and this mixture ratio is not to be modified throughout the duration of the blast cleaning operations without the written approval of the Engineer.

4. Achieve from abrasive blasting an anchor pattern profile a minimum of 1.0 mil, but not exceeding 2.0 mils. Provide anchor pattern standards in the form of a three-dimensional standard plate which depicts a commercial blast profile. Prepare a sample of the blasted surface on a representative steel plate measuring six inches by six inches by 1/4 inch or purchase standard industry plate samples of various blast finishes for comparisons. Purchase standard plates from NACE, meeting NACE TM-01-75, and conforming to NACE No. 3 standard using grit. Establish by agreement with the Engineer the visual standards that meet the specified anchor pattern and degree of cleanliness. Upon the establishment of the said standards, seal the steel plate using a clear acrylic coating, moisture proof plastic bag, or other approved means to protect the plate from surface contamination or corrosion. Use this plate as a visual comparitor during the blastcleaning and coating operations. Measure the anchor pattern or profile of the blasted surface using comparitor tape as specified herein.

5. Inspect the blast cleaned exterior pipe surface for adequate surface preparation prior to application of the primer. Surface comparitor tapes are to be used by the manufacture in at least eight random areas, selected by the Engineer, along any given 40-foot length of pipe. The results of the surface comparitor tapes are to be documented on the quality control sheet for each pipe section.

6. Coat each pipe section with primer and tape within the same day of being blast cleaned. Do not allow blasted and/or blasted and primed pipe to sit overnight. All blasted and primed pipe must be coated by the end of the day. No coating will be permitted on pipe sections showing evidence of rust.

H. Primer application shall conform to AWWA C214 and the following.

1. Prior to primer application, clean the pipe surface free of foreign matter such as sand, grease, oil, grit, rust particles, and dirt.

2. Apply the primer in a uniform thin film at the coverage rate recommended by the manufacturer. Meet the recommendations of the manufacturer for the state of dryness of the primer prior to the application of the inner layer of tape. Make available at all times, primed surfaces for inspection prior to the application of the inner layer tape. Maintain adequate safety precautions, as outlined in the manufacturer's fabrication plan, throughout the application of the primer.
3. Limit the application of primer to that length of pipe which can be taped within the same work day. Pipe coated with primer which was not taped within the same work day shall be rejected at the discretion of the Engineer. The primer shall be removed and the surface shall be reprimed.

4. Protect primer coated pipe sections from moisture, dirt, sand, and other potentially contaminating materials. Protect priming operations from, or suspended during, times of high wind. Sections not adequately protected shall be rejected by the Engineer. If rejection occurs due to contamination of the primer, completely remove the primer from the exterior of the pipe section and reprime the surface.

5. Thoroughly mix the primer by agitation using Jiffy Mixer or an approved equal powered by air or explosion proof electric motor. Continuously mix and agitate primer during application to prevent settling or lumping.

6. Apply primer only to a dry pipe surface. Whenever the ambient air temperatures are cold enough to cause gelling of the primer, the use of heaters will not be permitted to return the primer back to a fully liquid state. Use new primer at a minimum of 40 degrees F.

7. Apply storage primer to the exposed steel pipe at tape cutbacks to prevent oxidation of the cleaned metal surface. Spray apply minimum of 1-1/2 mils and maximum of 2-1/2 mils of storage primer to exposed steel per the manufacturer's recommendations. Do not place storage primer on the edge of the steel plate.

8. Certify the solvent of the primer and storage primer by the manufacturer stating compliance with air pollution control rules and regulations and all requirements of agencies and other governmental bodies having jurisdiction. Include air pollution control rules and regulations regarding the application of the primer in the manufacturer's fabrication plan.

I. Inner layer tape application:

1. Apply the inner layer tape directly onto the primed surface using approved mechanical dispensing equipment to assure adequate, consistent tension on the tape as recommended by the tape manufacturer. Use rollers to apply pressure on the tape as it comes in contact with the pipe. Make necessary adjustments to mechanical application equipment to assure a uniform, tight coating. Maintain a tight, smooth, mechanically induced, wrinkle-free coating throughout application process.

2. The application of tension shall be such that the width of tape will be reduced between 1-1/2 to 2 percent of tape width prior to the pull. Provide a pressure readout gauge and chart recorder, suitable to the Engineer, with the tape let-off machine to document the tape tension during application.

3. Apply inner layer tape at a minimum roll temperature of 70 degrees F. Continuously monitor the temperature of the tape within 12 inches of the point of contact with the pipe surface. Use a chart recorder, suitable to the Engineer, to document the temperature of the tape during application. Sections where the tape application tension and temperature is not maintained within manufacturer's recommendations shall be rejected, and the tape removed from the entire pipe section and reapplied.

4. Continuously electronically test the inner tape layer at 6,000 volts immediately following application of the tape by a holiday tester permanently mounted to the tape application station and equipped with an indicator light and audio buzzer, suitable to the Engineer to alert the workmen of the presence of holidays in the coating system.

5. Spirally wrap the inner layer tape over longitudinally welded pipe; however, for spiral welded pipe, the angle of the inner layer tape shall be wrapped as parallel as practicable to the spiral weld of the pipe or as approved by the Engineer. Provide a one inch nominal tape overlap, minimum overlap ¾ inch.

6. Splice each new roll by overlapping the new tape over the end of the preceding roll by at least six inches. Perform this end lap splice by hand or by a mechanical applicator such that the splice is
winkle free and maintains the continuity of the inner wrap coating. Maintain the wrapping angle of the new roll parallel to that of the previous roll.

7. Provide cutbacks ten inches from and parallel to the end of the pipe. Perform cutbacks using a cutting device that is guided from the end of the pipe to insure a uniform, straight cutback.

J. Mechanical outer layer tape application:

1. Apply the first mechanical outer layer of tape over the inner layer tape using the same type of mechanical equipment used in the application of the inner layer tape. No overlap splice of the other layer coinciding with the overlap splice of the inner layer will be permitted. Provide a minimum six-inch separation between overlap of splices. Apply two mechanical outer layers of tape as specified herein. The inner layer tape shall be electrically tested, inspected, and approved prior to the application of the first mechanical outer layer tape and the first mechanical outer layer tape shall also be visually inspected and approved prior to the application of the second mechanical outer layer tape. Ensure that both mechanical outer layer tapes are smooth, tight, and wrinkle-free.

2. Apply mechanical outer layer tapes in accordance with the requirements for the inner layer tape, except that the minimum tape roll application temperature shall be 90 degrees F. Monitoring for tension and temperature will be required for the mechanical outer layer tapes. The use of rollers to apply pressure on the tape is not required during application of the mechanical outer layer tapes. Holiday testing of the mechanical outer layer tapes is not required during tape application. Test the complete tape system prior to coating as specified herein.

K. Storage primer application shall conform to AWWA C214 as modified herein:

1. Prior to storage primer application, clean the pipe surface free from foreign matter such as sand, grease, grit, rust particles, and dirt.

2. Thoroughly mix the primer by agitation using Jiffy Mixer or an approved equal powered by air or explosion proof electric motor. Continuously mix and agitate primer during application to prevent settling or lumping.

3. Apply primer only to a dry pipe surface. Whenever the ambient air temperatures are cold enough to cause gelling of the primer, the use of heaters will not be permitted to return the primer back to a fully liquid state. Use new primer at a minimum of 40 degrees F.

4. Apply storage primer to the exposed steel pipe at tape cutbacks to prevent oxidation of the cleaned metal surface. Spray apply minimum of 1-1/2 mils and maximum of 2-1/2 mils of storage primer to exposed steel per the manufacturer's recommendations. Do not place storage primer on the edge of the steel plate.

5. Certify the solvent of the primer and storage primer by the manufacturer stating compliance with air pollution control rules and regulations and all requirements of agencies and other governmental bodies having jurisdiction. Include air pollution control rules and regulations regarding the application of the primer in the manufacturer's fabrication plan.

3.03 FITTINGS COATED AT THE PLANT

A. Coat fittings which cannot be machine coated in accordance with AWWA C209 using materials as specified herein. Weld bead preparation, surface preparation, blast cleaning, primer and tape application shall be as specified for straight run pipe. Apply an inner layer tape of Polyken # 932-50 with a one-inch nominal, 3/4-inch minimum, tape overlap on all plant coated fittings. Apply an outer layer of cold-applied plastic tape as specified herein with a 55 percent overlap on all plant coated fittings. Provide a minimum thickness of 110 mils for the total tape coat system for plant coated fittings.
B. When more than 30 percent of the tape coating is removed from the circumference of the pipe for the installation of fittings, remove the tape coating system remaining on the pipe. Reprime and retape the fitting and pipe in accordance with these specifications.

C. Test all completed tape coated fittings in the presence of the Engineer with an electrical flaw detector prior to installation of cement mortar coating. Applied voltage shall be in the range of 11,000 to 15,000 volts. Repair any holidays found.

D. Follow the procedure described herein for tape coating repair for fittings and field joints. Repair cement mortar coating defects in accordance with these specifications.

E. Apply cement mortar coating in accordance with Section 09871, Cement Mortar Coating, over the tape coated fittings immediately after completion of tape coating, testing, and inspections.

3.04 COATING OF FIELD JOINTS

A. Field cold-applied plastic tape coating shall be in accordance with AWWA C209, as modified herein.

B. Prior to welding any field joints, wrap an 18 inch strip of heat resistant material over the entire coated pipe sections on each side of the joint to be welded to avoid damage to the plant applied coating by the hot weld spatter. Do not use the coated portion of the pipe for grounding.

C. Immediately prior to exterior welding of the pipe for double welded lap joints, remove storage primer and wire brush area to be welded per the manufacturer's recommendations.

D. No tape coating will be permitted until the welding has been completed and the pipe section has cooled sufficiently so as not to damage the integrity of the tape coating system.

E. Do not permit trapped air under the tape in the joint.

F. After joint welding, remove flash rusting by mechanical means such as a wire brush. Wire brush the weld, storage primed steel and all exposed steel. Remove all burrs and weld slags to achieve a smooth surface.

G. Clean the pipe surface free of mud, mill lacquer, wax, tar, grease, or any foreign matter. Remove visible oil or grease using an approved solvent that will not leave any residue on the pipe surface. The pipe surface shall be free of any moisture and all foreign matter prior to the application of primer.

H. Prior to the application of the field applied tape coating, test the plant applied tape coating in the presence of the Engineer with an electrical flaw detector. Repair all holidays and physical damage to the plant applied tape coating prior to application of the field applied tape coating.

I. Pack irregularities in joint with elastameric joint filler.

J. Apply primer by brush or roller (four mil wet, one mil dry).

K. After primer has dried, apply tape to the joint and extend a minimum of three inches onto the mill coat. End splices shall be a minimum of six inches and shall be staggered. The tape coating shall overlap at least three inches on the adjacent tape wrap. Maintain 55 percent overlap on all field joint tape to produce a minimum thickness of 100 mils.

L. Apply tape with sufficient tension to conform with the surface irregularities. The finished wrap shall produce a smooth, wrinkle-free surface.

M. Test the final applied tape coating in the presence of the Engineer with an electrical flaw detector. Repair all holidays and physical damage to the final applied tape coating prior to application of the mortar coating.

N. Apply mortar coating in accordance with Section 02655, Installation of Pipe, over the tape coated joint immediately upon completion of tape wrapping, testing, and inspections.
3.05 INSPECTION OF TAPE COATING

A. Perform all coating work in the presence of the Engineer. Any coatings applied in the absence of the Engineer may be rejected.

1. Provide the Engineer with reasonable facilities and space, at the Contractor's expense, for the inspection, testing, and obtaining of any information required to determine the characteristics of the material to be used. Furnish to the Engineer at least two electrical pipe coating flaw detectors at the plant, and one electrical pipe coating flaw detector per pipe installation heading in the field, to aid in the inspection of the tape coating.

2. Provide free access to the Engineer to plants of the manufacturer furnishing the materials and to the worksite.

B. Holiday detection for tape coating:

1. Prior to the application of the mechanical outer layer tapes, electrically test the inner layer tape for any flaws in the coating with a suitable holiday detector as approved by the Engineer. Test the total tape coating system a second time immediately prior to installing cement mortar coating. The detector for both tests shall impress a voltage conforming to NACE Standard RP-02. The voltage to be used to electrically test the tape shall be included in the manufacturer's fabrication plan.

2. Clearly mark all holidays electrically or otherwise detected, due to flaws, or mishaps, upon discovery, and immediately repair. Discontinue wrapping of the first mechanical outer layer tape of any pipe section until the detected holiday has been repaired. Perform repairs using methods specified herein. After the repair, retest the affected areas with the holiday detector prior to the application of the outer layer wrap. This process will be done until the coating has successfully passed the test.

3.06 TAPE COATING REPAIRS

A. Furnish and install plant and field cold-applied plastic repair tapes in accordance with AWWA C209 using plant and field tape materials as specified herein. Provide the cold-applied plastic repair tapes from the same manufacturer as the plant applied plastic tape manufacturer. Repair tapes and primer shall be completely compatible with the tape system used for straight run pipe.

B. Repair any damage in the form of holidays, flaws or mishaps found in the total coating system by removing the outer layer tapes and inner layer tape from the damaged area of the pipe. Thoroughly clean the damaged area using methods and materials approved by the Engineer. The methods and materials to be used in repairing the damaged areas will depend on the type and cause of damage. After cleaning, apply a suitable primer, followed by a patch of repair tape over the affected area. Overlap the patch repair tape over the undamaged coating a minimum of four inches in all directions. Retest the repaired area with a holiday detector. Wrap an outer layer tape over the repaired area. The outer layer tape shall be the same material as the "Second Mechanical Outer Layer Tape" as specified herein. Overlap by a minimum six inches past the repair tape area. At the discretion of the Engineer, depending on the extent of the repair area, wrap the outer layer tape around the entire circumference of the pipe.

C. If the outer layer tapes are damaged and holidays or other flaws are not detected in the inner layer tape at the same area, the repair of the inner layer tape may not be necessary; however, if the damage is determined by the Engineer, to be severe enough to jeopardize the integrity of the inner layer tape, the Engineer will direct the Contractor to repair the inner layer tape. If such action is taken, remove the outer layer tapes up to the boundaries of the damaged area, taking care not to damage the inner layer tape any further. Before replacing the outer layer tapes, apply a holiday detector to the inner layer tape to determine that no damage has been made to this primary tape coating during the outer layer removal process. Perform the repair of the outer layer tapes in accordance with the requirements as described above. Overlap the repair tape over the undamaged coating a minimum of four inches in all directions.
D. When the repair area tests showing no holiday, apply a notation to the area indicating the test is satisfactory. Apply cement mortar coating over the cold-applied plastic tape coating.

3.07 PROTECTING COATED PIPE

A. Protect all coated surfaces from damage prior to and during the pipe installation in accordance with these specifications. At the fabrication plant, handle the coated pipe sections only after application of the cement mortar coating using belt slings or padded forklifts.

B. In transporting the coated pipe, rest the pipe in saddles not less than 36 inches wide shaped to the outside diameter of the coated pipe. The saddles shall be in contact with the bottom of the pipe along an arc of at least 60 degrees. Completely line saddles with not less than 5/8 inch thick rubber belting. This belting shall overlap the edges of the saddles not less than three inches. No nails nor any other fasteners that may damage the coated pipe will be permitted in installing the rubber belting on saddles. Any damaged pipe and coatings will be rejected. Rejected pipe may be repaired and retested when in the judgment of the Engineer an acceptable repair can be achieved.

C. Apply a storage wrap to the exposed tape ends to protect against ultraviolet exposure. Remove the storage wrap prior to completing the field joint. Any tape coated pipe, including exposed tape ends at the cement mortar hold-backs, subjected to ultraviolet exposure longer than 90 calendar days prior to installing cement mortar coating shall be physically inspected by the Engineer prior to installation of plant or field applied cement mortar coating. Ultraviolet degradation will not be accepted; except that if in the opinion of the Engineer, the degree of degradation will not affect the integrity of the coating.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes materials and application of fusion-bonded epoxy linings and coatings on steel pipe in accordance with AWWA C213, as modified herein.

B. Apply fusion-bonded epoxy linings or coatings to steel pipe, pipe fittings, and specials as shown on the Plans or as specified.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02653 Steel Pipe

B. Section 02655 Installation of Pipe

C. Section 09871 Cement Mortar Coating

D. Section 09872 Coal-Tar Coating

E. Section 09873 Cold-Applied Plastic Tape Coating

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Society for Testing and Materials

B. American Water Works Association
   C213 Standard for Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.

C. Steel Structures Painting Council
   SP-10 Near-White Blast Cleaning.

1.04 SUBMITTALS

A. Certification of test results of physical and performance characteristics of epoxy materials. Submit results of electrical holiday tests conducted on finished applications.

PART 2 - MATERIALS

2.01 EPOXY LINING AND COATING

A. Plant applied lining and coating shall be a 100 percent solids, thermosetting, fusion bonded, dry powder epoxy resin such as Scotchkote 206N, or equal. Epoxy lining and coating shall meet the following requirements:

   1. Abrasion resistance (min.): 1,000 cycles - 0.05 gram removed; 5,000 cycles - 0.115 gram removed (ASTM D1044, Tabor CS17 wheel, 1,000-gram weight)
2. Penetration resistance: 0 mil (ASTM G17)

3. Adhesion overlap shear, 1/8-inch panel, 0.010 glue line: 6,000 psi (ASTM D1002)

4. Impact (min. value): 160-in-lb (Gardner 5/8-inch radius tup)

2.02 FIELD APPLICATION MATERIALS

A. Field applied epoxy for patching, repairs, and lining and coating of field welded joints, shall be a two-component, 80 percent solids liquid resin, such as Scotchkote 306, or equal. Alternatively, the coating of field welded joints may use cold applied plastic tapes in accordance with Section 09873, Cold-Applied Plastic Tape Coating, or hot applied coal-tar tapes in accordance with Section 09872, Coal-Tar Coating.

PART 3 - EXECUTION

3.01 SHOP APPLICATION OF FUSION EPOXY LINING AND COATING

A. Apply fusion epoxy lining and coating in accordance with AWWA C213, except as modified below.

B. Grind 0.020 inch (minimum) off the weld caps on the pipe weld seams before beginning the surface preparation and heating of the pipe.

C. Grind surface irregularities, welds, and weld spatter smooth before applying the epoxy. The allowable grind area shall not exceed 0.5 square foot per location, and the maximum total grind area shall not exceed 2 square feet per pipe section. Do not use any pipe section in which these requirements cannot be met.

D. Uniformly preheat the pipe prior to blast cleaning to remove moisture from the surface. The preheat shall be sufficient to ensure that the pipe temperature is at least five degrees F above the dew point temperature during blast cleaning and inspection. Sandblast surfaces per SSPC SP-10. Protect beveled pipe ends from the abrasive blast cleaning.

E. Apply epoxy lining and coating by either the fluidized bed or the electrostatic spray process. Minimum thickness of lining and coating shall be 12 to 15 mils each. Heat and cure pipe linings and coatings per the resin manufacturer's recommendations.

F. For bell and spigot joints welded in the field, hold back from the end of each pipe section the shop applied epoxy lining and coating a sufficient distance such that the field welding will not damage the epoxy surface.

3.02 TESTING AND INSPECTION

A. Test lining and coating with a low-voltage wet sponge holiday detector in accordance with AWWA C213, Section 5.3.3. If the number of holidays or pinholes exceeds one per ten square feet, remove the entire pipe lining and coating and recoat the entire pipe or fitting.

B. Check for coating defects on the weld seam centerlines. There shall be no porous blisters, craters, or pimples lying along the peak of the weld crown.

C. Measure the coating thickness at three locations on each pipe section using a coating thickness gauge calibrated at least once per eight-hour shift. Record each measured thickness value. Where individual measured thickness values are less than the specified minimum thickness, measure the coating thickness at three-foot intervals along the pipe length. The average of these measurements shall exceed the specified minimum thickness value, and no individual thickness value shall be more than two mils below the specified minimum value. If a section of pipe does not meet these criteria, remove the entire lining and coating and reline and recoat the entire pipe section or fitting.
3.03 REPAIR OF DEFECTIVE EPOXY LINING AND COATING

A. Apply in accordance with AWWA C213, a two-part, 100 percent solids, liquid epoxy coating or a hot melt adhesive patching compound, to a minimum coating thickness of 12 mils to defective linings and coatings to areas smaller than 40 square inches. Patched areas shall overlap the parent or base coating a minimum of 1/2 inch. If a defective area exceeds 40 square inches, remove the entire lining and coating and reline and recoat the entire pipe section or fitting.

3.04 CEMENT MORTAR COATING FOR BURIED PIPE

A. After testing and inspecting, apply over the epoxy coating a one-inch thick cement mortar coating in accordance with Section 09871, Cement Mortar Coating, for each pipe section, fitting, and special that is to be buried. Hold back the cement mortar coating a sufficient length from the end of the pipe to provide clearance for field coating of the joint.

3.05 PRODUCT MARKING

A. Mark on the inside of the pipe a continuous, circumferential line, 1/16 inch wide, 12 inches from the end of each bell section. The circumferential line will be used to evaluate fit up during installation.

3.06 LINING AND COATING OF FIELD JOINT

A. Lining and coating of field joint shall be in accordance with the applicable material specification. For buried pipe, apply a cement mortar coating over the coated joint in accordance with Section 02655, Installation of Pipe.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes materials and field placement of cement mortar lining within pipes in accordance with AWWA C602, except as modified herein.

B. The finished inside diameter after lining shall be the nominal pipe diameter shown.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02653 Steel Pipe

B. Section 02655 Installation of Pipe

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Society for Testing and Materials


   C40 Test Method for Organic Impurities in Fine Aggregates for Concrete.

   C87 Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar.


   C150 Portland Cement.

B. American Water Works Association

   C602 Cement Mortar Lining of Water Pipelines Four inch (100 mm) and Larger, In Place.

C. State of California, Department of Transportation, Manual of Test Volumes 1-2-3 (Standard Test Methods)

   Test 417 - Testing Soils and Waters for Sulfate Content.

   Test 422 - Testing Soils and Waters for Chloride Content.

1.04 SUBMITTALS

A. Procedure, including access points, direction of lining operations, methods of curing, and methods for obtaining specified compressive strength.

B. Certification that cement complies with ASTM C150 and these specifications.

C. Certification that sand complies with sieve analysis, ASTM C136; test of organic impurities in sands for concrete, ASTM C40; test of the effect of organic impurities in fine aggregate on the strength of mortar, ASTM C87.
PART 2 - MATERIALS

2.01 CEMENT

A. Portland cement shall be Type II, low alkali, conforming to ASTM C150. Procure all cement from the same mill.

B. Pozzolanic material shall conform to the requirements of ASTM C618, Class N, with the following exceptions:

<table>
<thead>
<tr>
<th>Sulfur Trioxide (SO3), maximum percent:</th>
<th>4</th>
</tr>
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<tbody>
<tr>
<td>Pozzolanic activity index</td>
<td></td>
</tr>
<tr>
<td>With portland cement, at 28 days, minimum percentage of control:</td>
<td>85</td>
</tr>
<tr>
<td>With lime, at 7 days, minimum psi:</td>
<td>950</td>
</tr>
<tr>
<td>Water requirement, maximum, percentage of control:</td>
<td>110</td>
</tr>
<tr>
<td>Reactivity with cement alkalies</td>
<td></td>
</tr>
<tr>
<td>Reduction of mortar expansion at 14 days, minimum percent:</td>
<td>85</td>
</tr>
</tbody>
</table>

2.02 SAND

A. Sand shall consist of inert granular material having hard, strong, durable, uncoated grains produced from hard crystalline rock. Do not exceed the following limits for deleterious amounts of dust, clay lumps, shale, soft or flaky particles, mica, loam, oil, alkali, and other foreign materials:

<table>
<thead>
<tr>
<th>Substances</th>
<th>Percent By Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shale</td>
<td>1</td>
</tr>
<tr>
<td>Clay lumps</td>
<td>1</td>
</tr>
<tr>
<td>Mica and other deleterious substances</td>
<td>2</td>
</tr>
<tr>
<td>Sum of all deleterious substances</td>
<td>3</td>
</tr>
</tbody>
</table>

B. The color of the supernatant liquid shall not be darker than the standard specified therein when tested in accordance with the methods in ASTM C40.

C. Provide the grading of the sand to within the following limits:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 16</td>
<td>100</td>
</tr>
<tr>
<td>No. 20</td>
<td>90-100</td>
</tr>
<tr>
<td>No. 30</td>
<td>70-95</td>
</tr>
<tr>
<td>No. 50</td>
<td>15-60</td>
</tr>
<tr>
<td>No. 80</td>
<td>5-20</td>
</tr>
<tr>
<td>No. 100</td>
<td>1.5-5</td>
</tr>
<tr>
<td>No. 200</td>
<td>1-3</td>
</tr>
<tr>
<td>No. 400</td>
<td>0</td>
</tr>
</tbody>
</table>
D. Allow washed or saturated sand to drain at least 24 hours to a uniform moisture content before batching. Moisten dry sand before handling to prevent segregation.

E. Processing to include sorting, crushing, screening, blending, washing, separating out and wasting part of the natural materials, and other operations to make the available material conform to the requirements. In case the finer particles from the crushed coarse aggregate are mixed with sand from natural deposits, uniformly blend the two products before washing or screening to ensure a combined product of constant composition.

F. Provide sand of such quality that two-inch mortar cubes made with a mixture of cement and sand will develop compressive strengths at seven and 28 days at not less than 90 percent of the strengths developed by a mortar prepared in the same manner with the same cement and graded Ottawa testing sand, in accordance with the method prescribed by ASTM C87.

2.03 WATER

A. Water shall be free of organic materials and other impurities which might reduce the strength, durability or other quality of the cement mortar. Water shall have a pH of 7.0 to 9.0, a maximum chloride concentration of 500 mg/l (per Caltrans test method 422), and a maximum sulfate concentration of 500 mg/l (per Caltrans test method 417).

2.04 CEMENT MORTAR FOR CRACK REPAIR

A. Cement mortar for crack repair shall be Sikatop 123 Gel Mortar, or equal.

PART 3 - EXECUTION

3.01 CEMENT MORTAR MIX FOR FIELD-PLACED LINING

A. Provide 2,000 psi minimum 28 day compressive strength cement mortar for the lining composed of cement, processed sand, and water; well mixed; and of proportions and consistency to obtain a dense, homogenous lining that will adhere firmly to the pipe surface. Determine the exact proportions of each cement mortar lining mix and submit to the Engineer for acceptance prior to use. Proportion the cement mortar lining mix by volume for the specific application type. The cement mortar lining mix shall be composed of not less than the following proportion:

1. Pneumatic placed flash coating for hand trowelling: 1 part cement to 1.5 parts sand.
2. Field spin lining machine application: 1 part cement to 2 parts sand.
3. Pneumatic applied lining: 1 part cement to 3 parts sand.

B. When the mixture ratio for sand and cement has been determined, measurement of the dry material shall be by volume and controlled accurately throughout the course of the work, by either means of a box of known volume into which materials may be emptied and struck off, or by prepackaged bags of known weight and volume.

C. Control water to cement ratio and keep to a minimum, with an allowance being made as necessary for moisture which may collect on interior pipe surfaces, and as required for most effective machine operation and adhesion of mortar to the pipe.

D. Where premixed mortar is to be applied with a lining machine, perform premixing for a sufficient length of time, approximately three minutes, to obtain maximum plasticity. Apply such premixed mortar before initial set has taken place.
3.02 EQUIPMENT

A. Provide lining machine of a type that has been used successfully for similar work over a period of at least three years. A contractor may be required to present evidence that his organization, or designated subcontractor, has successfully performed similar work by the use of a machine of the type proposed to be used hereunder.

3.03 CLEANING OF THE PIPE BEFORE LINING

A. Prior to commencement of lining operations, clean the interior surfaces of the pipeline by mechanical methods. Remove water, loose scale, loose rust, dirt, existing coatings, and other foreign materials.

3.04 LINING THICKNESS

A. Install cement mortar lining in a procedure to provide continuous, dense, without variation in quality, and such that mortar lining adheres to the wall of the pipe at all points. Provide minimum lining thickness conforming to AWWA C602, Table 1, or as shown on the Plans. Provide lining with finished thickness tolerance of plus 1/4 inch, minus zero. Do not deviate finished surface by more than 1/16 inch from a 24-inch straight edge held against the lining.

3.05 OPENINGS

A. Temporarily close openings in the pipeline for manholes, outlets, and blowoffs. Cover with removable stoppers, coverings, or other devices to prevent the intrusion of cement mortar. Hand pack weld outlets with mortar to provide a smooth surface across the outlet prior to machine linings. Upon completion of the lining, remove stoppers, coverings, and other devices from openings and repair any lining damaged in the process. Trim, smooth, and point outlet openings.

3.06 QUALITY OF MACHINE APPLICATION

A. Immediately prior to the passage of the lining machine through the pipeline, remove sand, loose mortar, and other foreign material that has accumulated since completion of the preparation of surfaces.

B. Apply the lining in one course by use of a machine with an applicator head which will centrifugally project the mortar against the surface of the pipe without injurious rebound and with sufficient velocity to cause the mortar to be densely packed and to adhere in place. Do not pre-mortar joints in advance of machine applied lining without written approval of the Engineer. Do not use compressed air in the process of mixing or application. Mechanically control the rate of travel of the machine and the rate of discharge of mortar against the wall of the pipe so as to produce a smooth lining of uniform thickness throughout the interior of the pipeline. Provide the machine with attachments for mechanically troweling the mortar. The machine shall travel ahead of the lining so that the freshly placed and troweled mortar will not be touched until after it has set. Provide trowel arrangement such that the pressure applied to the lining will be uniform, producing a smooth surface without spiral shoulders or undulations, and producing a lining of uniform thickness.

C. Remove lining in areas where the quality is defective, such as sand pockets, voids, oversanded areas, blisters, drummy areas, excessively cracked areas, and thin spots, to the pipe wall. Repair all temporary and shrinkage cracks greater the 1/16 inch in width with cement mortar. In removing defective lining, cut the material back to a square shoulder. Do not provide featheredge joints. Replace with pneumatically placed mortar to the full required thickness of the mortar lining.

D. Complete hand-finished work and replacement of defective lining within 24 hours of completion of each day's machine applied mortar lining. Slow or stop machine application of mortar lining to assure time for hand patching of defective machine-lined areas.
3.07 LINING OF BENDS AND SPECIALS

A. Line with pneumatically applied mortar the interior surfaces of bends and special sections 36 inches or more in diameter which cannot satisfactorily be lined by machine placing, and the interior surfaces of any short sections or closing courses of pipe temporarily omitted and subsequently placed after completion of the machine-placed mortar lining. Line steel fittings of a diameter less than 36 inches with mortar by hand plastering, provided that the methods used shall be such as to produce a lining substantially equivalent in quality to the machine-placed mortar lining.

B. Finish cement mortar to a smooth surface by troweling with steel finishing trowels.

3.08 CURING

A. Begin curing operations immediately after final inspection of each day's work. Close pipe and maintain a moist atmosphere in each section of the pipeline by means of mist head sprinklers which operate so as to keep the lining continuously damp. Continue curing operations until the pipeline is filled.

B. Sprinkle the exterior surfaces of steel pipe exposed to the sunlight with water during daylight hours during the lining finishing and curing period.

C. Within one week of completing the lining in a portion of the pipeline, isolate each portion of the pipeline from subsequent pipe to be lined. Fill the isolated pipeline with water and maintain filled with water until the completion of the contract, unless otherwise directed by the Engineer.

3.09 PIPE MARKINGS

A. Upon completion of the field lining operation, mark the location of each field joint clearly and permanently. Mark the pipe mark number corresponding to the pipeline layout sheet on the inside of the pipe with four-inch tall letters at springline on the right-hand side of the pipe when facing downstream by pipe stations.

END OF SECTION
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PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes materials and application of polyurethane linings and coatings on steel pipe in accordance with AWWA C222-99.

B. Apply polyurethane linings and coatings to steel pipe, pipefittings and specials as shown on Plans or as specified.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02653 Steel Pipe

B. Section 02655 Installation of Pipe

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Society for Testing and Materials

   D16 Definition of Terms Relating to Paint, Varnish, Lacquer, and Related Products.


   G95 Standard Test Method for Cathodic Disbondment Test of Pipeline Coatings.

B. American Water Works Association

   C200 Steel Water Pipe six inch and Larger.

C. Steel Structures Painting Council

   PA-10 Near-White Blast Cleaning.

   PA-2 Measurement of Dry Paint Thickness with Magnetic Gauges.
1.04 SUBMITTALS

A. Certification of test results of physical and performance characteristics of polyurethane materials. Submit results of electric holiday tests conducted on finished applications.

PART 2 - MATERIALS

2.01 POLYURETHANE LINING & COATING

A. Lining and coating material shall consist of an ASTM D16 Type V polyurethane material using a one to one mix ratio of methylene bisphenyl diisocyanate resin with a polyether polyol resin.

B. Tensile Adhesion: No less than 2,000-psi when tested according to ASTM D4541.

C. Impact Resistance: 60 inch pounds when tested with 5/8 inch ball according to ASTM D2794.

D. Abrasion Resistance: less than 100 mg weight loss per 1,000 revolutions of a CS-17 wheel when tested according to ASTM D4060

E. Chemical Resistance: less than 5 percent weight change after 90 day immersion test according to ASTM D543 (10 percent HSO, 10 percent HCl, 30 percent NaOH, deionized water.

F. Water Absorption: maximum of 3 percent according to ASTM D 570.

G. Cathodic Disbondment: less than 10-mm radius from edge of initial holiday when tested according to ASTM G95 (run at 1-1/2 volts for 28 days).

H. Hardness: minimum Durometer hardness of 65 on the Shore D scale according to ASTM D2240.

I. Polyurethane lining and coating shall be Madison Corropipe II PW, or equal.

2.02 FIELD APPLICATION MATERIALS

A. Field applied polyurethane for patching, repairs, and lining and coating of field-welded joints, shall be compatible with originally applied coating or as recommended by the original lining and coating manufacturer for such purposes.

PART 3 - EXECUTION

3.01 SHOP APPLICATION OF POLYURETHANE

A. Apply polyurethane lining and coating in accordance with AWWA C222-99, except as modified below.

B. Grind 0.020 inch (minimum) off the weld caps on the pipe weld seams before beginning the surface preparation and heating of pipe.

C. Grind surface irregularities, welds, and weld spatter smooth before applying the polyurethane. The allowable grind area shall not exceed 1/2 square feet per location, and the maximum total grind area shall not exceed two square feet per pipe section. Do not use any pipe section in which these requirements cannot be met.

D. Uniformly preheat the pipe prior to blast cleaning to remove moisture from the surface. The preheat shall be sufficient to ensure that the pipe temperature is at least five degrees F above the dew point temperature during blast cleaning and inspection. Sandblast surfaces per SSPC SP-10. Protect beveled pipe ends from the abrasive blast cleaning.
E. Apply polyurethane lining and coating according to the manufacturer’s application instructions for manual or automatic spray techniques in order to achieve the required lining or coating thickness. The minimum applied dry film thickness shall be 20 mils on interior lining and 25 mils on exterior coating. Maximum lining and coating thickness shall be applied as recommended by the coating manufacturer. The thickness of the lining and coating shall be measured according to SSPC PA-2. Recoating over new or existing coatings shall be accomplished only as specified by the lining and coating manufacturer with approval from the Engineer as required.

F. For bell and spigot joints and other field-welded joints, a holdback that is free of the lining and/or coating shall be left uncoated. The holdback shall be of sufficient width such that the field welding will not damage the polyurethane surface. This joint and holdback area is to receive the same surface preparation as the rest of the pipe.

3.02 TESTING AND INSPECTION

A. Test lining and coating with a low-voltage wet sponge holiday detector in accordance with AWWA C222-99, Section 5.5.4. If the number of holidays or pinholes exceeds one per ten square feet, remove the entire pipe lining and coating and recoat the entire pipe or fitting.

B. Check for coating defects on the weld seam centerlines. There shall be no porous blisters, craters, or pimples lying along the peak of the weld crown.

C. Measure the lining and/or coating thickness at three locations on each pipe section using a coating thickness gauge and record each measured thickness value. Where individual measured thickness values are less than the specified minimum thickness, measure the lining and/or coating thickness at three foot intervals along the pipe length. The average of these measurements shall exceed the specified minimum thickness value, and no individual thickness value shall be more than two mils below the specified minimum value. If a section of pipe does not meet these criteria, remove the entire lining and/or coating and reline the entire pipe section or fitting.

D. The finished appearance of the lining and/or coating shall be generally smooth and free of sharp protrusions. A minor amount of sags, dimpling and curtaining which otherwise meets the specification requirements shall not be considered cause for rejection.

3.03 REPAIR OF DEFECTIVE POLYURETHANE LINING AND COATING

A. Completely remove damaged or improperly applied lining and/or coating according to AWWA C222-99 and manufacturer’s recommendations. Areas that are less than the specified minimum dry film thickness shall be recoated as recommended by the manufacturer. Surface preparation, material application, material thickness, testing, and inspection shall be according to manufacturer’s recommendations and as specified herein.

3.04 PRODUCT MARKING

A. Mark on the inside of the pipe a continuous, circumferential line, 1/16 inch wide, 12 inches from the end of each bell section. The circumferential line will be used to evaluate fit-up during installation.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes materials and application of painting and coating systems.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02653 Steel Pipe
B. Section 02655 Installation of Pipe
C. Section 03000 General Concrete Construction
D. Section 05120 Structural Steel, Aluminum and Miscellaneous Metalwork
E. Section 09820 Crystalline Waterproofing
F. Section 15058 PVC Pipe and Fittings, Three Inches and Smaller
G. Section 15100 Valves
H. Section 15108 Air-Release and Vacuum-Relief Valves
I. Section 15122 Pipe Couplings and Expansion Joints
J. Section 15142 Wall Pipes, Seep Rings, and Penetrations
K. Section 15144 Pipe Hangers and Supports

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American National Standards Institute
   A159.1 Surface Preparation Specifications.
B. American Society for Testing and Materials
   D2697 Test Method for Volume Non-Volatile Matter in Clear or Pigmented Coatings.
C. American Water Works Association
   C105 Polyethylene Encasement for Ductile Iron Pipe Systems.
D. National Sanitation Foundation
   NSF-61 Drinking Water System Components Health Effects.

1.04 SUBMITTALS

A. Manufacturer's data sheets showing the following information:
   1. Percent solids by volume.
2. Minimum and maximum recommended dry-film thickness per coat for prime, intermediate, and finish coats.

3. Recommended surface preparation.

4. Recommended thinners.

5. Statement verifying that the specified prime coat is recommended by the manufacturer for use with the specified intermediate and finish coats.

6. Application instructions including recommended equipment and temperature limitations.

7. Curing requirements and instructions.

8. Life expectancy/frequency and methods of recoating or repairing.

B. Color swatches.

C. Certificate identifying the type and gradation of abrasives used for surface preparation.

D. Certification that all paints and coatings comply with Los Angeles and San Diego Air Pollution Control Districts requirements.

PART 2 - MATERIALS

2.01 PAINTING AND COATING SYSTEMS

A. For each painting and coating system, the required surface preparation, prime coat, intermediate coat (if required), topcoat, and coating thicknesses are described below. Mil thicknesses shown are minimum dry-film thicknesses.

2.02 SUBMERGED METAL

A. System No. 7 - Submerged Metal, Potable Water.
   1. Type: Epoxy.
   2. Service Conditions: For use with structures, piping, or equipment immersed in potable water. System No. 7 shall be in accordance with NSF-61.

2.03 SUNLIGHT EXPOSED METAL

A. System No. 10 - Sunlight Exposed Metal, Corrosive Environment.
   1. Type: High-build epoxy intermediate coat, with an inorganic zinc prime coat and a pigmented polyurethane finish coat.
   2. Service Conditions: For use with sunlight exposed metal structures or pipes subjected to water condensation; chemical fumes, such as hydrogen sulfide; salt spray; and chemical contact.
4. **Prime Coat:** Self-curing, two-component inorganic zinc-rich coating recommended by the manufacturer for overcoating with a high-build epoxy finish coat. Minimum zinc content shall be 12 pounds per gallon. Apply to a thickness of three mils. Products: Tnemec 90E92, Carboline Carbo Zinc 11 HS, Ameron Dimetcote 21-5, or equal. Color to be red or gray.

5. **Intermediate Coat:** Tnemec Series 69, Carboline 890, Ameron Amercoat 385, or equal. Apply to a thickness of five mils.

6. **Finish Coat:** Two-component pigmented aliphatic or acrylic polyurethane recommended by the manufacturer for overcoating a high-build epoxy coating. Apply to a thickness of at least 4 mils. Products: Tnemec Endura-Shield Series 75, Carbothane 134 HG, Ameron Amershield, or equal. Color to be greenish blue.

**B. System No. 15 - Sunlight Exposed Metal, Atmospheric Weathering Environment.**

1. **Type:** Gloss alkyd enamel having a minimum volume solids content of 46 percent with alkyd primer.

2. **Service Conditions:** For use on exterior metal and piping subject to sunlight and weathering.

3. **Surface Preparation:** SSPC SP-6.

4. **Prime Coat:** Carboline Multibond 150, Tnemec 4-55, Ameron 5105, or equal, applied to minimum dry film thickness of two mils.

5. **Finish Coat:** One coat of Carboline Rustarmor 139, 3.0 mils; two coats of Tnemec Series 2H, 1.5 mils each; two coats of Ameron 5405, 1.5 mils each; or equal.

**2.04 EXPOSED METAL**

**A. System No. 11 - Exposed Metal, Corrosive Environment**

1. **Type:** An inorganic zinc prime coat with a high-build epoxy intermediate coat and high build epoxy topcoat.

2. **Service Conditions:** For use with metal structures or pipes subjected to water condensation; chemical fumes, such as hydrogen sulfide; salt spray; and chemical contact.

3. **Surface Preparation:** SSPC-10.

4. **Prime Coat:** Self-curing, two-component inorganic zinc-rich coating recommended by the manufacturer for overcoating with a high-build epoxy finish coat. Minimum zinc content shall be 12 pounds per gallon. Apply to a thickness of three mils. Products: Tnemec 90E92, Carboline Carbo Zinc 11 HS, Ameron Dimetcote 21-5, or equal. Color to be red or gray.

5. **Intermediate Coat:** Tnemec Series 69, Carboline 890, Ameron Amercoat 385, or equal. Apply to a thickness of five mils.

6. **Finish Coat:** Tnemec Series 69, Carboline 890, Ameron Amercoat 385, or equal. Apply to a thickness of five mils. Color to be greenish blue.

**2.05 BURIED METAL**

**A. System No. 21 - Buried Metal.**

1. **Type:** High solids epoxy having a minimum solids volume of 80 percent (ASTM D 2697).

2. **Service Conditions:** Buried metal, such as valves, flanges, structural steel, and fittings.
4. Coating System: Tnemec 104 HS, Carboine 890, Ameron Amerlock 400, or equal. Apply one or more coats to a thickness of 16 mils. Color to be white.

B. System No. 24 - Buried Metal.
1. Type: Corrosion-resisting grease.
2. Service Conditions: Buried metal, such as bolts, bolt threads, tie rods, and nuts.
3. Surface Preparation: SSPC SP-3 or SP-6.
4. Coating: NO-OX-ID GG-2 as manufactured by Sanchem, Inc. Apply to a minimum thickness of 1/4 inch. Wrap the buried metal unit with an eight mil polyethylene wrap per AWWA C105.

2.06 PVC AND CPVC
A. System No. 41 - PVC, CPVC, and FRP, Ultraviolet Exposure.
1. Type: Pigmented polyurethane enamel.
2. Service Conditions: PVC or CPVC piping and FRP exposed to sunlight.
3. Surface Preparation: SSPC SP-1. Then lightly abrade the surface with medium-grain sandpaper.
4. Prime Coat: None.
5. Finish Coat: One coat of Rustoleum 9400, Tnemec Series 175, Ameron 450 HS, Carboine 134 Hg or equal. Apply to a minimum thickness of two mils.

2.07 NONFERROUS METALS
A. System No. 51 - Exposed Cast Iron, Aluminum, and Concrete Insulation.
1. Type: Bituminous paint having a minimum volume solids of 64 percent coal-tar pitch based.
2. Service Conditions: Coat areas of aluminum grating, stairs, structural members or aluminum fabrications, in contact with concrete with this system.
3. Surface Preparation: Dust blast.
4. Prime Coat: Per manufacturer's recommendation.
5. Finish Coat: Two coats of Carboine Bitumastic Super Service Black, 12 mils each; two coats of Tnemec 46-465 H.B. Tnemecol, 10 mils each; or equal.

B. System No. 52 - Exposed Metal, Galvanized and Nonferrous.
1. Type: Alkyd enamel.
2. Service Conditions: Coat galvanized and nonferrous metal surfaces with this system before applying topcoat.
3. Surface Preparation: Dust blast.
4. Prime Coat: Tnemec Series 27 Typoxy, Carboine Multibond 120, or equal.
5. Finish Coat: Tnemec 2H Hi Build Tneme-gloss, four mils; Carboline Rustarmor 139; or equal.

2.08 ABRASIVES FOR SURFACE PREPARATION

A. Abrasives used for preparation of iron and steel surfaces shall be one of the following:
   1. Silica sand or mineral grit, 16 to 30 or 16 to 40 mesh.
   2. Garnet, 20 to 40 mesh.
   3. Crushed iron slag, 100 percent retained on No. 80 mesh.
   4. SAE Grade G-40 or G-50 iron or steel grit.

B. Abrasives used for preparation of copper and aluminum surfaces shall be one of the following:
   1. Crushed slag, 80 to 100 mesh.
   2. Very fine silica sand, 80 to 100 mesh.

C. In the above gradations, 100 percent of the material shall pass through the first stated sieve size and 100 percent shall be retained on the second stated sieve size.

2.09 ORGANIC ZINC PRIMER FOR FIELD TOUCH-UP AND SHOP COATING

A. Organic zinc coating system shall have a minimum zinc content of 12 pounds per gallon. Coating shall be of the two- or three-component converted epoxy, epoxy phenolic, or urethane type. Products: Tnemec 90-97, Carboline 859, Ameron 68HS, or equal; applied to a minimum dry-film thickness of three mils. Organic zinc primer shall be manufactured by the prime coat manufacturer.

B. Where shop-applied inorganic zinc primers cannot be used because of volatile organic compound regulations, the above organic zinc primers may be substituted for the specified inorganic zinc primers.

2.10 CONCRETE AND MASONRY COATING SYSTEMS

A. System No. 32 - Exposed Concrete and Masonry, Atmospheric Weathering Environment.
   1. Type: Acrylic enamel or acrylic latex having a minimum volume solids of 36 percent.
   2. Service Conditions: Concrete or masonry exposed to sunlight and weathering.
   3. Prime Coat: Water-borne acrylic or cementitious acrylic emulsion having a minimum solids volume of 40 percent. Apply one coat of Carboline Flexxide Block Filler to fill all voids, pores, and cracks; Ameron 400 BF; Tnemec 54-660 Masonry Filler; Porter 896; or equal.
   4. Finish Coat: Two coats of Carboline 3350, two mils each; two coats of Ameron 220, two mils each; two coats of Tnemec Series 6, two mils each; two coats of Porter 520, two mils each; or equal.

2.11 WOOD AND MASONRY SYSTEM

A. System No. 60 - Wood and Masonry
   1. Type: Acrylic latex coating having a minimum volume solids of 40 percent.
   2. Service Conditions: Weather-exposed or enclosed concrete masonry and wood.
3. Surface Preparation: Surfaces shall be dry, clean, and free of contaminants. Allow masonry to cure 28 days, level protrusions, and remove mortar splatter.


5. Finish coat: Two coats of Tnemec Series 6, Tneme-cryl, two mils each; two coats of Carboline 3350, two mils each; two coats of Porter 520, two mils each; or equal.

PART 3 - EXECUTION

3.01 WEATHER CONDITIONS

A. Do not paint in the rain, wind, snow, mist, and fog or when steel or metal surface temperatures are less than five degrees F above the dew point.

B. Do not apply paint when the relative humidity is above 85 percent or the temperature is above 90 degrees F.

C. Do not paint when temperature of metal to be painted is above 120 degrees F.

D. Do not apply alkyd or inorganic zinc paints if air or surface temperature is below 40 degrees F or expected to be below 40 degrees F within 24 hours.

E. Do not apply epoxy and polyurethane paints on an exterior or interior surface if air or surface temperature is below 60 degrees F or expected to drop below 60 degrees F in 24 hours.

3.02 SURFACE PREPARATION

A. Do not sandblast or prepare more surface area in one day than can be coated in one day; prepare surfaces and apply coatings the same day. Remove all sharp edges, burrs, and weld spatter. Do not sandblast PVC, CPVC, or FRP piping or equipment. Do not sandblast epoxy- or enamel-coated pipe that has already been factory coated, except to repair scratched or damaged coatings.

B. Surface preparation shall conform with the SSPC (Steel Structure Painting Council, Surface Preparation Specifications, ANSI A159.1) specifications as follows:

<table>
<thead>
<tr>
<th>Solvent Cleaning</th>
<th>SP-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand Tool Cleaning</td>
<td>SP-2</td>
</tr>
<tr>
<td>Power Tool Cleaning</td>
<td>SP-3</td>
</tr>
<tr>
<td>White Metal Blast Cleaning</td>
<td>SP-5</td>
</tr>
<tr>
<td>Commercial Blast Cleaning</td>
<td>SP-6</td>
</tr>
<tr>
<td>Brush- Off Blast Cleaning</td>
<td>SP-7</td>
</tr>
<tr>
<td>Pickling</td>
<td>SP-8</td>
</tr>
<tr>
<td>Near White Blast Cleaning</td>
<td>SP-10</td>
</tr>
</tbody>
</table>

C. Wherever the words "solvent cleaning," "hand tool cleaning," "wire brushing," "blast cleaning," or similar words are used in these specifications or in paint manufacturer's specifications, they shall be understood to refer to the applicable SSPC specifications listed above.

D. Dust blasting is defined as cleaning the surface through the use of very fine abrasives, such as siliceous or mineral abrasives, 80 to 100 mesh. Apply a fine etch to the metal surface to clean the surface of any contamination or oxide.
E. Remove oil and grease from metal surfaces in accordance with SSPC SP-1. Use clean cloths and cleaning solvents and wipe dry with clean cloths. Do not leave a film or greasy residue on the cleaned surfaces before sandblasting.

F. Remove weld spatter and weld slag from metal surfaces and grind smoothly rough welds, beads, peaked corners, and sharp edges including erection lugs in accordance with SSPC SP-2 and SSPC SP-3.

G. Neutralize welds with a chemical solvent that is compatible with the specified coating materials. Use clean cloths and chemical solvent. Wipe dry with clean cloths. Do not leave a residue on the cleaned surfaces.

3.03 ABRASIVE BLAST CLEANING

A. Use dry abrasive blast cleaning for metal surfaces. Do not use abrasives in automatic equipment that have become contaminated. When shop or field blast cleaning with handheld nozzles, do not recycle or reuse blast particles.

B. After blast cleaning and prior to application of coating, dry clean surfaces to be coated by dusting, sweeping, and vacuuming to remove residue from blasting. Apply the specified primer or touch-up coating within the period of an eight-hour working day. Do not apply coating over damp or moist surfaces. Reclean prior to application of primer or touch-up coating any blast cleaned surface not coated within said eight-hour period.

C. Keep the area of the work in a clean condition and do not permit blasting particles to accumulate and constitute a nuisance or hazard.

D. During sandblast cleaning, prevent damage to adjacent coatings. Schedule blast cleaning and coating such that dust, dirt, blast particles, old coatings, rust, mill scale, etc., will not damage or fall upon wet or newly coated surfaces.

3.04 SURFACE PREPARATION FOR CONCRETE AND MASONRY

A. Do not apply coating until concrete has cured at least 28 days.

B. Concrete and masonry surfaces on which coatings are to be applied shall be of even color, gray, or gray-white. The surface shall have no pits, pockets, holes, or sharp changes of surface elevation.

C. Detergent clean the concrete or masonry surface with trisodium phosphate per ASTM D4258. Scrubbing with a stiff-bristle fiber brush shall produce no dusting or dislodging of cement or sand. Sprinkling water on the surface shall produce no water beads or standing droplets. Concrete and masonry shall be free of laitance and slick surfaces.

3.05 SHOP-APPLIED PRIME COATS

A. After application of primer to surfaces, allow coating to cure for a minimum of two hours before handling to minimize damage.

B. When loading for shipment to the project site, use spacers and other protective devices to separate items to prevent damaging the shop-primed surfaces during transit and unloading. If wood spacers are used, remove wood splinters and particles from the shop-primed surfaces after separation. Use padded chains or ribbon binders to secure the loaded items and minimize damage to the shop-primed surfaces.

C. Cover shop-primed items 100 percent with protective coverings or tarpaulins to prevent deposition of road salts, fuel residue, and other contaminants in transit.

D. Handle shop-primed items with care during unloading, installation, and erection operations to minimize damage. Do not place or store shop-primed items on the ground or on top of other work unless ground or work is covered with a protective covering or tarpaulin. Place shop primed items above the ground upon platforms, skids, or other supports.
3.06 FIELD TOUCH-UP OF SHOP-APPLIED PRIME COATS

A. Remove oil and grease surface contaminants on metal surfaces in accordance with SSPC SP-1. Use clean rags wetted with a degreasing solution, rinse with clean water, and wipe dry.

B. Remove dust, dirt, salts, moisture, chalking primers, or other surface contaminants that will affect the adhesion or durability of the coating system. Use a high-pressure water blaster or scrub surfaces with a broom or brush wetted with a solution of trisodium phosphate, detergent, and water. Before applying intermediate or finish coats to inorganic zinc primers, remove any soluble zinc salts that have formed by means of scrubbing with a stiff bristle brush. Rinse scrubbed surfaces with clean water.

C. Remove loose or peeling primer and other surface contaminants not easily removed by the previous cleaning methods in accordance with SSPC SP-7. Take care that remaining primers are not damaged by the blast cleaning operation. Remaining primers shall be firmly bonded to the steel surfaces with blast cleaned edges feathered.

D. Remove rust, scaling, or primer damaged by welding or during shipment, storage, and erection in accordance with SSPC SP-10. Take care that remaining primers are not damaged by the blast cleaning operation. Remaining primers shall be firmly bonded to the steel surfaces with blast cleaned edges feathered.

E. Use repair procedures on damaged primer which protects adjacent primer. Blast cleaning may require the use of lower air pressure, smaller nozzles, and abrasive particle sizes, short blast nozzle distance from surface, shielding, and/or masking.

F. Remove dust, blast particles, and other debris after abrasive blast cleaning of damaged and defective areas by dusting, sweeping, and vacuuming; then apply the specified touch-up coating.

G. Surfaces that are shop primed with inorganic zinc primers shall receive a field touch-up of organic zinc primer to cover all scratches or abraded areas.

H. Field touch-up other surfaces that are shop primed with the same primer used in the original prime coat.

3.07 PAINTING SYSTEMS

A. Provide materials for a specified painting system, including primer, intermediate, and finish coats by the same manufacturer. Thinners, cleaners, driers, and other additives shall be as recommended by the paint manufacturer for the particular coating system.

B. Deliver paints to the jobsite in the original, unopened containers.

3.08 PAINT MIXING

A. Prepare multiple-component coatings using all of the contents of the container for each component as packaged by the paint manufacturer. Do not use partial batches. Do not use multiple-component coatings that have been mixed beyond their pot life. Provide small quantity kits for touch-up painting and for painting other small areas. Mix only the components specified and furnished by the paint manufacturer. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

3.09 APPLICATION OF COATINGS

A. Conform to the requirements of SSPC PA-1. Follow the recommendations of the coating manufacturer including the selection of spray equipment, brushes, rollers, cleaners, thinners, mixing, drying time, temperature and humidity of application, and safety precautions.
B. Stir, strain, and keep coating materials at a uniform consistency during application. Apply each coating evenly, free of brush marks, sags, runs, and other evidence of poor workmanship. Use a different shade or tint on succeeding coating applications to indicate coverage where possible. Finished surfaces shall be free from defects or blemishes.

C. Do not use thinners unless recommended by the coating manufacturer. If thinning is allowed, do not exceed the maximum allowable amount of thinner per gallon of coating material. Stir coating materials at all times when adding thinner. Do not flood the coating material surface with thinner prior to mixing. Do not reduce coating materials more than is absolutely necessary to obtain the proper application characteristics and to obtain the specified dry-film thicknesses.

D. Remove dust, blast particles, and other debris from blast cleaned surfaces by dusting, sweeping, and vacuuming. Allow ventilator fans to clean airborne dust to provide good visibility of working area prior to coating applications. Remove dust from coated surfaces by dusting, sweeping, and vacuuming prior to applying succeeding coats.

E. Apply coating systems to the specified minimum dry-film thicknesses as measured from above the peaks of the surface profile.

F. Apply primer immediately after blast cleaning and before any surface rusting occurs, or any dust, dirt, or any foreign matter has accumulated. Reclean surfaces by blast cleaning that have surface colored or become moist prior to coating application.

G. Apply a brush coat of primer on welds, sharp edges, nuts, bolts, and irregular surfaces prior to the application of the primer and finish coat. The brush coat shall be done prior to and in conjunction with the spray coat application. Apply the spray coat over the brush coat.

3.10 SURFACES NOT TO BE COATED

A. Do not paint the following surfaces unless otherwise noted on the Plans or in other specification sections. Protect during the painting of adjacent areas:

1. Concrete walkways.
2. Mortar coated pipe and fittings.
4. Metal letters.
5. Glass.
6. Roofings.
7. Fencing.
8. Copper tubing, red brass piping, and PVC piping except where such piping occurs in rooms where the walls are painted, or required for color coding.
9. Electrical fixtures except for factory coatings.
12. Brass and copper, submerged.
13. Buried pipe, unless specifically required in the piping specifications.
14. Fiberglass items, unless specifically required in the FRP specifications.
15. Aluminum handrail, stairs, and grating.
3.11 PROTECTION OF SURFACES NOT TO BE PAINTED

A. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process. Mask openings in motors to prevent paint and other materials from entering the motors.

3.12 SURFACES TO BE COATED

A. Coat surfaces as described below:

1. Coat mechanical equipment as described in the various mechanical equipment specifications. Color shall match the color of connecting piping.

2. Coat above ground and exposed piping or piping in vaults and structures as described in the various piping specifications. Color shall be as selected by the Engineer.

3. Coat valves as described in the various valve specifications. Above ground valves, or valves in vaults and structures, shall match the color of connecting piping.

4. Coat aluminum surfaces in contact with concrete per System No. 51.

5. Coat buried flanges, nuts and bolts, valves, flexible pipe couplings and valve boxes per System No. 21 and System No. 24.

6. Coat above ground structural steel or structural steel located in vaults and structures as described in Section 05120, Structural Steel, Aluminum and Miscellaneous Metalwork.

7. Coat concrete and masonry surfaces where shown on the Plans.

3.13 DRY-FILM THICKNESS TESTING

A. Measure coating thickness specified for metal surfaces with a calibrated magnetic-type dry-film thickness gauge. Provide dry-film thickness gauge as manufactured by Mikrotest or Elcometer. Check each coat for the correct dry-film thickness. Do not measure within eight hours after application of the coating.

B. A minimum of five spot measurements shall be taken in a given area to assure proper coat dry film thickness. The average of these measurements shall not be less than the specified thickness. No single spot measurement shall be less than 80 percent, nor more than 120 percent, of the specified thickness.

3.14 REPAIR OF IMPROPERLY COATED SURFACES

A. If the item has an improper finish color or insufficient film thickness, clean and recoat the surface with the specified paint material to obtain the specified color and coverage. Sandblast or power-sand visible areas of chipped, peeled, or abraded paint, feathering the edges. Then prime and finish coat in accordance with the specifications. Work shall be free of runs, bridges, shiners, laps, or other imperfections.

END OF SECTION
PART 1 - GENERAL

1.01 SCOPE
A. This section covers hydrostatic leakage testing of water-retaining concrete structures.
B. Perform all cleaning, flushing, and testing, of all water-retaining structures and appurtenant piping, including conveyance of test water from designated source to point of use, and including all disposal thereof, complete and acceptable, all in accordance with the requirements of the Contract Documents.

1.02 GENERAL
A. Perform all testing work in the presence of the Engineer. Notify the Engineer at least three days in advance of the time and place at which testing will be performed.
B. Water for cleaning, flushing and the initial testing will be furnished in accordance with Section 01510, Temporary Utilities. Conserve water through collection and reuse in subsequent tests. Following completion of testing work, dispose the water in a manner acceptable to the Engineer and, unless otherwise permitted by the Engineer, do not allow disposed water to enter other parts of the Water Authority-owned system.

1.03 RELATED WORK SPECIFIED ELSEWHERE
A. Section 02676 Pressure Testing of Piping

1.04 CONTRACTOR SUBMITTALS
A. A testing schedule, including proposed plans for water conveyance, control, and disposal. Submit testing schedule for Engineer review and acceptance a minimum of 15-work days prior to the start of testing work.
B. Qualifications of certified testing laboratory.
C. Backflow prevention plans.

PART 2 – MATERIALS

2.01 ALLOWABLE LEAKAGE
A. The maximum allowable leakage, measured in terms of volume of water loss during the seven-day test period, shall not exceed 0.2 percent.
B. Water loss due to evaporation and water gain due to precipitation during the test period shall be determined and added or deleted, respectively, to the maximum allowable leakage values specified herein.
C. Water-retaining concrete structures, whether tested or not, shall be free from visible leaks. Damp spots on exterior wall surfaces will be considered visible leaks if water can be picked up on a dry hand or facial tissue. Damp spots on wall footings will be permitted. Locate all visible leaks which have not spontaneously plugged or demonstrated a definite decrease in the rate of leakage over a seven-day observation period and repair by and at the expense of the Contractor in a manner acceptable to the Engineer.
D. The Contractor shall be responsible for locating and repairing each visible leak which is discovered during the leakage testing period, any subsequent retesting period, and throughout the warranty period stipulated in the Contract Documents, regardless of any amount of measured leakage that may have been below the specified maximum allowable leakage during the leakage test. Perform all repairs, including draining, cleaning, disinfecting, refilling, and retesting to the satisfaction of the Engineer at the expense of the Contractor.

PART 3 - EXECUTION

3.01 TEST PROCEDURES

A. The procedure and sequence of testing shall be subject to review and acceptance by the Engineer.

B. Unless otherwise specified, perform hydrostatic leakage testing after all pipe sleeves have been installed and the exterior waterproofing material has been applied, but before backfilling or interior dampproofing material has been applied. Do not perform hydrostatic testing sooner than 14 days after all portions of structure walls and roof systems have been completed.

C. Hydrostatically test water-retaining concrete structures, including the walls, floor, piping and pipe penetrations, for leakage following construction of the roof slab and prior to completion of backfilling and cleaning.

D. Test adjacent structures having common walls individually at different times to permit examination of the dividing walls for leaks.

E. Provide temporary plugs during testing for pipe connections or openings to structures not provided with valves.

F. Fill the structure to be tested to an elevation of one foot below the overflow elevation and allow to stand for not less than seven days. At the end of the seven day period, add water to the structure as needed to raise the water level to one foot below the overflow elevation.

G. Measurements of water loss will be taken by the Engineer over a subsequent seven-day period. If the measured drop in water level excluding water loss due to evaporation exceeds 0.2 percent of the volume at this time and does not show a definite decreasing trend during the seven-day period, drain, repair, clean, disinfect, refill, and retest the structure to the satisfaction of the Engineer.

H. Final acceptance of leakage tests may be deferred for 30 days providing periodic measurements of water level indicating a definite decrease in leakage rate. Additional water may be added when and in the amounts directed by the Engineer. If the observed leakage rate exceeds the allowable leakage specified, drain, repair, clean, disinfect, and retest the reservoir until the observed leakage rate is reduced to the specified allowable amount.

I. Leak test the roof slab of concrete structures by erecting temporary curbs or berms that will flood the roof surface to a minimum depth of one inch. Maintain the flooded roof section continuously and as directed by the Engineer until the interior roof surface can be fully observed for leaks. Repair all found leaks using epoxy injection methods or other means acceptable to the Engineer. Repeat roof slab leak test following completion of all repairs.

3.02 REPETITION OF TEST PROCEDURE

A. If the observed leakage exceeds the allowable, repeat the testing procedure at the Contractor’s expense. Water used for retesting shall be obtained at the Contractor’s expense.
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section describes the general requirements for selecting piping materials; selecting the associated bolts, nuts, and gaskets for flanges for the various piping services in the project; and miscellaneous piping items such as flange insulation kits and insulating unions.

1.02 DEFINITIONS OF BURIED PIPING

A. Buried piping is piping buried in the soil, commencing at the wall or beneath the slab of a structure. Where a coating is specified, provide the coating up to the structure wall. Piping encased in concrete is considered to be buried.

1.03 PIPING SERVICE

A. Piping service is determined by the fluid conveyed, regardless of the pipe designation.

1.04 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02653 Steel Pipe
B. Section 02655 Installation of Pipe
C. Section 15058 PVC Pipe and Fittings, Three Inches and Smaller
D. Section 15100 Valves
E. Section 15122 Pipe Couplings and Expansion Joints
F. Section 16640 Cathodic Protection

1.05 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American National Standards Institute
   B1.1 Unified Inch Screw Threads.
B. American Society for Testing and Materials
   A193 Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service.
   A194 Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service.
   A307 Specification for Carbon Steel Bolts and Studs, 6000 psi Tensile.
   F436 Hardened Steel Washers.
1.06 SUBMITTALS

A. Manufacturer's catalog data. Show dimensions, materials of construction by ASTM reference and grade, and coatings.

PART 2 - MATERIALS

2.01 PIPING MATERIALS

A. The Plans show alternative piping materials for certain services. Do not intermix piping materials. Use the same pipe material for all pipe sizes in all locations for the given piping service.

2.02 BOLTS AND NUTS FOR FLANGED CONNECTIONS

A. Use ASTM A193, Grade B7 bolts and ASTM A194, Grade 2H nuts for flanged connections.

B. Provide a washer under each nut and under each bolthead. Washers shall conform to ASTM F436. Washers shall be sized such that no part of the washer shall project beyond the flange outside diameter. Washers shall be flush with the flange surface and shall not impinge on any welded surface between the flange and the pipe, valve, or fitting to which the flange is attached.

C. Bolts shall be of such length that not less than 1/4 inch nor more than 1/2 inch shall project above nut in tightened position. All bolt heads and nuts shall be hexagonal, except where special shapes are required.

D. Certify that the bolts and nuts have been proof tested.

E. Provide bolts with hexagonal cap heads for tapped holes.

2.03 BOLTS AND NUTS FOR FLANGES FOR PVC PIPE

A. Use carbon steel, ASTM A307, Grade B, bolts and nuts for flanges located in concrete encasements, in outdoor above-ground installations, and in above-ground structures.

B. Use stainless steel, ASTM A193, Grade B8M, Class 2 and ASTM A194, Grade 8M, bolts and nuts for buried and submerged flanges, and flanges located below ground in vaults.

C. Provide a washer under each nut and under each bolt head. Use washers of the same material as the nuts.

D. Certify that the bolts and nuts have been proof tested.

2.04 LUBRICANT FOR STAINLESS STEEL BOLTS AND NUTS

A. Lubricant shall be Husky Lube "O" Seal by Husk-ITT Corporation, or equal.

2.05 GASKETS FOR FLANGES FOR STEEL PIPING IN WATER SERVICE

A. Use full face 1/8 inch thick gaskets of the following non-asbestos materials:

1. Cloth-inserted rubber. Products: John Crane Company Style 777, or equal. Gaskets shall be suitable for a pressure of 200 psi at a temperature of 180 degree F if design pressure is less than or equal to 200 psi.

2. Acrylic or Aramid fiber bound with Nitrile. Products: Garlock "Bluegard 3000," Klinger "Klingersil C4400," or equal. Gaskets shall be suitable for a water pressure of 500 psi at a temperature of 400 degree F.
2.06 GASKETS FOR FLANGES FOR PVC AND CPVC PIPING

A. For flanged joints, use full faced gaskets, 1/8 inch thick, made of ethylene propylene rubber having a Type A durometer hardness of 50 to 70 when tested in accordance with ASTM D2240. When the mating flange has a raised face, provide a flat ring gasket filler between the PVC flange gasket and the adjacent flange.

2.07 FLANGE INSULATING KITS

A. Flange insulating kits shall be in accordance with Section 16640, Cathodic Protection.

2.08 INSULATING UNIONS

A. For insulating unions, use a molded nylon sealing sleeve mounted in a three-piece malleable-iron (ASTM A 47 or A 197) body. Use threaded ends (ANSI B2.1) when connecting to steel piping, and copper solder joint when connecting to copper piping. Minimum working pressure shall be 150 psi.

2.09 THREADED INSULATING COUPLINGS

A. Threaded Insulating couplings shall provide dielectric protection from electrolytic corrosion at points where piping of dissimilar metals is joined (brass to steel, etc.). Couplings shall be approved by the manufacture for use on water, gas, and oil, and shall withstand a hydrostatic test pressure of 1000 PSI at 225 degrees F. Couplings shall be lined with inert, non-conductive, linen-impregnated laminate material and threaded to NPS standards with sufficient separation between pipe ends to prevent bridging. Couplings shall be Lochinvar “V”-Line, or equal.

PART 3 - EXECUTION

3.01 INSTALLING FLANGED PIPING

A. Install flanged piping in accordance with Section 02655, Installation of Pipe.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes furnishing and installing pressure gages, including all fittings, snubbers, connections, gaskets, supports, and accessories in the locations shown on the Plans, or specified herein.

1.02 SUBMITTALS

A. Manufacturer’s catalogue data showing materials of construction and descriptive literature.

PART 2 - MATERIALS

2.01 PRESSURE AND VACUUM GAGES

A. Pressure gages shall be provided as shown on the Plans.

B. Pressures gauges shall be industrial quality liquid filled type with Type 316 stainless steel movement and stainless steel or alloy case. Unless otherwise shown or specified, gauges shall have a 3-1/2 inch dial, 1/4 inch threaded connection, and a Type 316 stainless steel snubber adapter.

C. Gages shall be calibrated to read in ten psi increments, with an accuracy of plus or minus 1 percent, to 150 percent of the working pressure or vacuum of the pipe or vessel to which they are connected. Dial face shall have black graduations on white background.

D. All pressure gages shall be supplied with a pulsation dampener valve to prevent pressure surges from damaging the gage.

E. Pressure gauges shall be manufactured by Ashcroft; U.S. Gauge (Ametek), SG; Marshalltown, Series 1009, or equal.

F. Snubber shall be manufactured by Cajon Company, Weksler Instrument Corp, or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All gages shall be installed with the face in the vertical position, at the locations shown on the Plans, and in strict accordance with the manufacturer’s installation instructions. Install on mounting assembly with shutoff valve as shown. Care shall be taken to minimize the effect of water hammer or vibrations on the gages.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes materials, installation, and testing of copper tubing and fittings for water and air service.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02675 Disinfection of Piping
B. Section 02676 Pressure Testing of Piping
C. Section 15100 Valves
D. Section 15144 Pipe Hangers and Supports
E. Section 15190 Equipment, Piping, and Valve Identification

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American National Standards institute
   B1.20.1 Pipe Threads, General Purpose.
   B16.15 Cast Bronze Threaded Fittings.
   B16.18 Cast Copper Alloy Solder Joint Pressure Fittings.
   B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
   B31.3 Chemical Plant and Petroleum Refinery Piping.

B. American Society of Mechanical Engineers
   Section IX Boiler and Pressure Vessel Code.

C. American Society for Testing and Materials
   B32 Specification for Solder Metal.
   B42 Specification for Seamless Copper Pipe, Standard Sizes.
   B61 Specification for Steam of Valve Bronze Castings.
   B62 Specification for Composition Bronze or Ounce Metal Castings.
   B75 Specification for Seamless Copper Tube.
   B88 Specification for Seamless Copper Water Tube.
1.04 SUBMITTALS

A. Shop drawings of pipe and fittings for each piping system.
B. Materials list showing material of tubing and fittings with ASTM reference and grade.
C. Manufacturer’s catalog data and descriptive literature for wye strainers, unions, and coatings.
D. Manufacturer’s catalog data and descriptive literature for solder.

PART 2 - MATERIALS

2.01 COPPER TUBING

A. Copper tubing shall conform to ASTM B88. Tubing located above floors or suspended from ceilings shall be Type L, hard drawn, except that tubing utilizing nut and ferrule fittings and joints shall be soft annealed (Temper O). Buried tubing or tubing located beneath floor slabs shall be Type K, annealed.

2.02 FITTINGS

A. Wrought copper solder joint seamless fittings shall be designed for use with copper water tube and conform to ASTM B75 and ANSI B16.22.
B. Cast copper solder joint pressure fitting shall be designed for use with copper water tube and conform to ANSI B16.18.
C. Cast bronze threaded fittings shall be designed for use with copper or brass pipe and nipples and conform to ANSI B16.15, Classes 125.
D. Nut and ferrule fittings shall be brass, Swagelok type, as manufactured by Crawford Fitting Company, utilizing a nut and dual ferrule design to connect to tubing. End connections shall be of the union type.

2.03 SOLDER

A. Solder shall be ASTM B32, Grade Sb5, 95-5 tin-antimony, or Grade Sn94-4 tin-silver solder.

2.04 PIPE AND NIPPLES

A. Short threaded nipples and pipe shall be brass conforming to ASTM B43 or copper conforming to ASTM B42, regular wall thickness, except that nipples and pipe sizes one inch and smaller shall be extra strong. Threads shall conform to ANSI B1.20.1.

2.05 WYE STRAINERS

A. Wye strainers shall be bronze, ASTM B61 or B62, with 60-mesh Type 304 or 316 stainless-steel screens. Working pressure shall be at least 150 psi. Provide bronze plug on the tapped blowoff outlet. Provide one spare screen for each strainer. Strainers shall be Walworth Figure 3699-1/2, Muessco No. 351, or equal.

2.06 UNIONS

A. Unions shall be the same size as the pipe, three part, with copper flare end connections. Unions shall be bronze, ASTM B61 or B62. Unions shall be Mueller H-15400, Jones J-1528, or equal.
B. Insulating unions shall conform to Section 15000, Piping Schedule and General Piping Requirements.
PART 3 - EXECUTION

3.01 STORAGE AND HANDLING

A. Exercise care in handling, loading, unloading and storage of pipe and fittings to avoid distortion, scratches, gouges, cracks, dents and scuffing. Store all pipe and fittings protected from the elements until ready for installation.

3.02 JOINT AND FITTING SELECTION

A. Use solder joints and fittings in buried and exposed tubing service, except that fittings and joints 3/8 inch and smaller in exposed service may be of the nut and ferrule type with flared end connections or compression joint connections.

B. Use threaded joints and fittings in buried and exposed copper and brass piping.

3.03 INSTALLATION

A. Install copper tubing accurately to the indicated alignment and grade, and in accordance with the approved Shop Drawings. The routing of copper tubing may be changed to avoid obstructions only with the approval of the Engineer.

B. Cut tubing square and remove burrs. Clean both the inside and outside of fitting and pipe ends with steel wool and muriatic acid before soldering. Prevent annealing of fittings and tubing when making connections. Do not miter joints for elbows or notch straight runs of pipe for tees.

C. Bends in soft copper tubing shall be long sweep. Shape bends with shaping tools. Form bends without flattening, buckling, or thinning the tubing wall at any point.

D. Brazing procedures shall be in accordance with Articles XII and XIII, Section IX, of the ASME Boiler and Pressure Vessel Code. Solder shall penetrate to the full depth of the cup in joints and fittings. Solderers shall comply with ANSI B31.3, paragraph 333.

E. Install pipe without springing, forcing, or stressing the pipe or any adjacent connection valves or equipment.

F. Clean threaded joints by wire brushing or swabbing. Apply Teflon joint compound or Teflon tape to male pipe threads before installing threaded fitting. Joints shall be watertight.

G. Provide an insulating union at the point of transition from copper tubing to ferrous piping.

H. Insulate bare copper surfaces from any supports that can cause galvanic action.

3.04 INSTALLING UNIONS

A. Provide unions on exposed piping three inches and smaller where shown on the Plans and as follows:
   1. Provide a union at every change in direction (horizontal and vertical).
   2. Provide a union 6 to 12 inches downstream of valves.
   3. Provide a union every 40 feet in straight piping runs.

3.05 PRESSURE TESTING AND DISINFECTION

A. Test copper piping for leakage in accordance with Section 02676, Pressure Testing of Piping. Disinfect piping in accordance with Section 02675, Disinfection of Piping.
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PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes materials, installation, and testing of polyvinyl chloride pipe and fittings of size three inches and smaller for use in process piping having a maximum operating pressure of 150 psi and having a maximum operating temperature of 105 degrees F.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02200 Earthwork
B. Section 02676 Pressure Testing of Piping
C. Section 09900 Painting and Coating
D. Section 15000 Piping Schedule and General Piping Requirements
E. Section 15144 Pipe Hangers and Supports

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American National Standards Institute
   B1.20.1 Pipe Threads, General Purpose.
   B16.5 Pipe Flanges and Flanged Fittings.
B. American Society for Testing and Materials
   D1785 Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
   D2774 Recommended Practice for Under-ground Installation of Thermoplastic Pressure Piping.
   D2855 Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.

1.04 SUBMITTALS

A. Materials list for review. Submit manufacturer's recommended method of installing buried pipe. Show alignments and offsets for "snaking" buried pipe.
PART 2 - MATERIALS

2.01 PIPE MATERIALS

A. Pipe. Pipe shall be Schedule 80, Type I, Grade 1 (Class 12454-B), conforming to ASTM D1784 and D1785.

B. Nipples. Short nipples shall be the same as the PVC pipe.

C. Fittings. Fittings shall be Schedule 80 and shall conform to ASTM D2464 for threaded fittings and ASTM D2467 for socket-type fittings.

D. Flanges. PVC flanges shall be made of the same material as the pipe. Flanges shall match the dimensions of ANSI B16.5, Class 150, steel flanges.

E. Unions. Unions shall have socket-type ends, Viton O-rings, and shall be Schedule 80. Material shall be Type I, Grade 1 PVC, per ASTM D1784.

2.02 JOINTS

A. Pipe and fitting joints shall be socket welded except where threaded and flanged joints are required to connect to unions, valves, and equipment.

B. Solvent cement for socket joints shall comply with ASTM D2564.

C. Gaskets for flanged joints shall be full-faced, 1/8 inch thick, made of ethylene propylene rubber having a Type A durometer hardness of 50 to 70 when tested in accordance with ASTM D2240. When the mating flange has a raised face, provide a flat ring gasket filler between the PVC flange gasket and the adjacent flange.

PART 3 - EXECUTION

3.01 GENERAL

A. Do not install PVC pipe when the temperature is below 40 degrees F or above 90 degrees F. Store loose pipes on racks with a maximum support spacing of three feet. Provide shades for pipe stored outdoors or installed outdoors until the pipe is filled with water. Do not install or store PVC pipe in areas of potential hazardous materials.

B. Store fittings indoors in their original cartons.

C. Store solvent cement indoors or, if outdoors, shade from direct sunlight exposure. Do not use solvent cements which have exceeded the shelf life marked on the storage container.

D. Before installation, check pipe and fittings for cuts, scratches, gouges, buckling, kinking, or splitting on pipe ends. Do not drag PVC pipe over the ground, drop it onto the ground, or drop objects on it. Remove any pipe section containing defects by cutting out the damaged section as a complete cylinder.

E. Cut pipe ends square and remove all burrs, chips, and filings before joining pipe or fittings. Bevel solvent welded pipe ends as recommended by the pipe manufacturer.

3.02 SOLVENT WELDED JOINTS

A. Prior to solvent welding, remove fittings and couplings from their cartons and expose them to the air at the same temperature conditions as the pipe for at least one hour.

B. Wipe away loose dirt and moisture from the inside diameter and outside diameter of the pipe end and the inside diameter of the fitting before applying solvent cement. Do not apply solvent cement to wet surfaces.
C. Make solvent welded joints per ASTM D2855.
D. Allow at least eight hours of drying time before moving solvent welded joints or subjecting the joints to any internal or external loads or pressures.

3.03 FLANGED JOINTS

A. Prior to assembly, coat threaded portions of stainless-steel bolts and nuts with lubricant.
B. Tighten bolts on PVC flanges by tightening the nuts diametrically opposite each other using a torque wrench. Accomplish complete tightening in stages with the final torque values as shown in the following table:

<table>
<thead>
<tr>
<th>Pipe Size (inches)</th>
<th>Final Torque (foot/pounds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 to 1-1/2</td>
<td>10 to 15</td>
</tr>
<tr>
<td>2 to 3</td>
<td>20 to 30</td>
</tr>
</tbody>
</table>

3.04 THREADED JOINTS

A. The threading of PVC pipe will not be permitted to make a threaded connection. Use glue by threaded adapter fittings to make a threaded connection.
B. Apply Teflon thread compound or Teflon tape lubricant to threads before screwing on the fitting.

3.05 INSTALLING UNIONS

A. Provide unions on exposed piping as follows:
   1. Provide a union at every change in direction (horizontal and vertical)
   2. Provide a union six to 12 inches downstream of valves.
   3. Where shown on the Plans.

3.06 INSTALLING BURIED PIPE

A. Grade trench bottom to be continuous, smooth, and free of rocks. See the details on the Plans for trench dimensions, pipe bedding, and backfill.
B. After the pipe has been solvent welded and the joints have set, snake the pipe in the trench per the pipe manufacturer's recommendations in order to allow for thermal expansion and contraction of the pipe.
C. Do not backfill the pipe trench until solvent welded joints have set. Support pipe uniformly and continuously over its entire length on firm, stable soil. Do not use blocking to change pipe grade or to support pipe in the trench.
D. Install buried PVC pipe in accordance with ASTM D2774 and pipe manufacturer's recommendations. Backfill materials in the zone between the trench bottom and to a point eight inches above the top of the pipe shall be imported sand per Section 02200, Earthwork. Compact by vibratory equipment. Apply backfill in layers having a maximum thickness of eight inches.

3.07 INSTALLING ABOVE-GROUND PIPE

A. Install pipe on pipe hangers and supports as detailed on the Plans and as specified in Section 15144, Pipe Hangers and Supports. Install pipe without springing, forcing, or stressing the pipe or the adjacent valves and equipment to which the pipe is connected.
3.08 PAINTING AND COATING
   A. Coat piping per Section 09900, Painting and Coating, System No. 41.

3.09 HYDROSTATIC TESTING
   A. Perform hydrostatic testing for leakage in accordance with Section 02676, Pressure Testing of Piping.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes materials, testing, and installation of manually operated valves and process valves including butterfly, ball, lubricated plug, and miscellaneous cocks and drains.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02676 Pressure Testing of Piping
B. Section 03480 Precast Concrete Vaults
C. Section 05120 Structural Steel, Aluminum, and Miscellaneous Metalwork
D. Section 09900 Painting and Coating
E. Section 15000 Piping Schedule and General Piping Requirements
F. Section 15108 Air-Release and Vacuum-Relief Valves
G. Section 15190 Equipment, Piping, Duct, and Valve Identification

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American National Standard Institute
   B1.20.1 Pipe Threads, General Purpose (inch).
   B16.1 Cast Iron Pipe Flanges and Flanged Fittings.
   B16.10 Face-to-Face and End-to-End Dimensions of Valves.
   B46.1 Surface Texture.
B. American Society for Testing and Materials
   A276 Specification for Stainless and Heat-Resisting Steel Bars and Shapes.
   A322 Specification for Steel Bars, Alloy, Standard Grades.
   A536 Specification for Ductile Iron Castings.
   B16 Specification for Free-Cutting Brass Rod, Bar, and Shapes for use in Screw Machines.
   B61 Specification for Steam or Valve Bronze Castings.
B62 Specification for Composition Bronze or Ounce Metal Castings.
B427 Specification for Gear Bronze Alloy Castings.
B505 Specification for Copper-Base Alloy Continuous Castings.
B584 Specification for Copper Alloy Sand Castings for General Applications.

C. American Water Works Association
C504 Standard for Rubber-Seated Butterfly Valves.
C507 Ball Valves six inches through 48 inches.

1.04 SUBMITTALS

A. Manufacturer's catalog data, calculations and detail construction sheets showing all valve parts and describing by material of construction and specification (such as AISI, ASTM, SAE, or CDA). Identify each valve by tag number to which the catalog data and detail sheets pertain.

B. Show valve dimensions including laying lengths. Show port sizes. Show dimensions and orientation of valve actuators, as installed on the valves. Show location of internal stops for gear actuators.

C. Show valve linings and coatings. Submit manufacturer's catalog data and descriptive literature.

D. Six copies of a report verifying that the valve interior linings have been tested for holidays and lining thickness. Describe test results and repair procedures for each valve. Do not ship valves to project site until the reports have been approved by the Engineer.

E. A valve summary sheet giving the station, valve structure, type, manufacturer, size, pressure rating, drilling pattern and model number of each valve; and type, manufacturer and model number of the valve actuator.

1.05 QUALITY ASSURANCE

A. Valve Testing: Shop-Test each valve body under a test pressure equal to twice its design water-working pressure. The hydrostatic seat tests for all valves, including lubricated tapered plug valves, shall be made free of any sealant. The hydrostatic seat test for all valves shall be performed with the valve actuator installed. The valve manufacturer must provide a six-week notice to the Engineer prior to performing tests, and allow full access for inspection of testing.

B. Bronze Parts: All interior bronze parts of valves shall conform to the requirements of ASTM B 62, or where not subject to dezincification, to ASTM B 584.

C. Prior to shipment, the Contractor shall submit for all valves over 12 inches in size, certified copies of the torque and hydrostatic factory tests, showing compliance with this Specification and the applicable standards of AWWA, ANSI, ASTM etc.

D. Valve manufacturers shall have a minimum of five years of recent continuous product history in the USA waterworks industry.

PART 2 - MATERIALS

2.01 GENERAL

A. Supply valves complete with operating handwheels or levers, chainwheels, extension stems, gear actuators, operating nuts, chains, and wrenches required for operation.
B. Valves shall have the name of the manufacturer and size of the valve cast or molded onto the valve body or bonnet or shown on a permanently attached plate.

C. Direction of flow shall be cast or stamped on the valve body, unless the valve is bidirectional.

D. Coordinate the drilling pattern and orientation of bolt holes between valves and adjacent flanges. Use only flat-faced flanges for all valves.

E. Provide valve identification per Section 15190, Equipment, Piping, Duct and Valve Identification.

F. Provide valve lifting device, as shown on the Plans, for 18 inch and larger ball valves.

2.02 MANUAL ACTUATORS

A. Provide lever or wrench actuators for exposed valves three inches and smaller.

B. Provide enclosed gear actuators on butterfly ball, and plug valves four inches and larger. Gear actuators shall be worm and gear type.

C. Design gear actuators assuming that the differential pressure across the plug or disc is equal to the pressure rating of the valve.

D. Gear actuators shall be enclosed, lubricated with oil or grease, and provided with seals on shafts to prevent entry of dirt and water into the actuator. Gear actuators for valves located above ground or in vaults and structures shall have as shown on the Plans, either handwheels or operating nuts and extension stems to valve boxes at grade level. The actuators for valves in exposed service shall contain a dial indicating the position of the valve disc or plug. Attach two-inch operating nut to the input shaft with a keyway and Allen screw.

E. Worm and gear actuators shall be of the totally enclosed design so proportioned as to permit operation of the valve under full differential pressure rating of the valve with a maximum pull of 80 pounds on the handwheel and a maximum input of 150 feet-pounds on the operating nut. Provide stop limiting devices in the actuators in the open and closed positions. Actuators shall be of the self-locking type to prevent the disc or plug from creeping. Design actuator components between the input and the stop-limiting devices to withstand without damage a pull of 200 pounds for handwheel or chainwheel actuators, and an input torque of 300 foot-pounds for operating nuts when operating against the stops. Actuators shall be oriented to operate with valve stem extensions as shown on the Plans.

F. Self-locking worm gear shall be a one-piece design of gear bronze material (ASTM B427), accurately machine cut. Actuators for lubricated plug valves may use ductile iron or high strength steel gearing. The worm shall be hardened alloy steel (ASTM A322, Grade G41500; or ASTM A148, Grade 105-85), with thread ground and polished. Helix angle of worm and gear shall be designed and cut at 3.5 degrees or less to prevent creep, unless other means to prevent creep are employed and are approved by the Engineer. The actuator shall prevent creeping of the valve under all flow conditions. Support worm gear shaft at each end by ball or tapered roller bearings. Provide reduction gearing to meet maximum torque and pull design requirement. The reduction gearings shall run in a proper lubricant. Worm gear actuators shall be Limitorque Model HBC, EIM Type WO, or equal.

G. Actuators or levers shall open valves by turning counterclockwise.

H. Provide open and close limit switches with one normally open and normally closed contact for mainline isolation valves within the flow control facility. Mount switches on the valve such that the corresponding switch transfers when the valve is fully open and fully closed. Limit switches shall be Square D Class 9007, HA 1 arm, C54B2 switch.
2.03 VALVE BOXES

A. Valve boxes for manually operated valves shall be provided and installed as shown on the Plans. Valve boxes shall be cast in the vault roof for right of way type structures or shall be encased in concrete a minimum six inches outside the frame diameter for street type structures. Valve boxes for street type structures shall be set on a six-inch diameter by 12-gauge steel casing into the vault roof.

B. Each valve box shall be equipped with a valve position indicator and adapter plate designed to fit securely in the valve box. The indicators shall show valve position and direction and number of turns required to fully open or close the valve. All internal gearing within the valve position indicator shall be sealed. Each unit shall be shipped ready for field installation complete with all materials. Valve position indicators shall be Pratt Diviner, or equal.

C. Valve boxes for throttling valves shall be 10-1/4 inch diameter concrete body with cast iron frame and cover, Brooks Products 4-TT Series, or equal. Valve boxes for isolation valves set in right of way type structures shall be 5-1/4 inch diameter cast iron frame and cover, Tyler Pipe, or equal. Valve boxes for isolation valve for street type structures shall be South Bay Foundry SBF 1208N, or equal.

2.04 VALVE STEM EXTENSIONS

A. Extension stems shall be hot-dipped galvanized round steel bar or pipe and shall be complete with a two inch AWWA square operating nut and adapter socket. Extension stems fitted with position indicators shall have a 1-1/4 inch square adapter for operating the indicator. The extension stems shall be designed to withstand up to 300 foot-pounds of input torque.

B. Valve stem extension brackets shall be hot-dipped galvanized steel.

2.05 CHAINWHEELS AND GUIDES

A. Chainwheels and guides shall be Clow Figure F-5680, DeZurik Series W or LWG, Stockham, or equal. Chainwheels and guides shall be galvanized. Chains shall extend to within four feet of the operating floor. Chains shall be Type 304 stainless steel. Pillow blocks shall be cast iron with ball bearings and locking collar to secure shaft and grease fitting for lubrication.

2.06 PAINTING AND COATING

A. Coat metal valves and accessories located above ground or in vaults and structures per Section 09900, Painting and Coating, System No. 10 or System No. 11. Apply the specified prime coat at the place of manufacture. Finish coat shall match the color of the adjacent piping. Coat handwheels the same as the valves.

B. Line the interior metal parts of metal valves four inches and larger, excluding seating areas and bronze and stainless-steel pieces, per Section 09900, Painting and Coating, System No. 7. Apply the lining at the place of manufacture or at the facilities of a United States distributor who is certified and authorized by the manufacturer of the valve and the supplier of the lining materials to perform such application.

C. Test the valve interior linings at the factory with a low-voltage (22.5 to 80 volts, with approximately 80,000 ohm resistance) holiday detector, using a sponge saturated with a 0.5 percent sodium chloride solution. The lining shall be holiday free.

D. Measure the thickness of the valve interior linings and repair areas having insufficient film thickness in accordance with Section 09900, Painting and Coating.

2.07 PACKING, O-RINGS, AND GASKETS

A. Packing, O-rings, and gaskets shall be one of the following non-asbestos materials:
   1. Teflon.
2. Kevlar aramid fiber.
3. Acrylic or aramid fiber bound by nitrile. Products: Garlock "Bluegard," Klinger "Klingersil C4400," or equal.
5. Cotton impregnated with Buna-N.

2.08 RUBBER SEATS

A. Rubber seats shall be made of a rubber compound that is resistant to free chlorine and monochloramine concentrations up to 10 mg/l in the fluid conveyed.

2.09 GATE VALVES

A. Above ground Gate Valves Three Inches and Smaller: Above ground threaded end gate valves, 1/4 inch through three inches, for water service shall be rising stem, screwed bonnet, solid wedge disc type, Class 200, having a minimum working pressure of 400 WOG psi at a temperature of 150 degrees F. Ends shall be female threaded, ANSI B1.20.1. Materials of construction shall be as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Material</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body, bonnet</td>
<td>Bronze</td>
<td>ASTM B61</td>
</tr>
<tr>
<td>Disc</td>
<td>Bronze</td>
<td>ASTM B61 or B584 (Alloy C97600)</td>
</tr>
<tr>
<td>Stem</td>
<td>Copper/Silicon</td>
<td>ASTM B584 (Alloy C87600)</td>
</tr>
<tr>
<td>Seat rings</td>
<td>Stainless Steel</td>
<td>ASTM A276, Type 410</td>
</tr>
</tbody>
</table>

B. Handwheels shall be aluminum, brass, or malleable iron. Packing shall be Teflon or Kevlar aramid fiber. Valves shall be Crane 400, Stockham B-132, or equal.

2.10 BUTTERFLY VALVES

A. Thrust Bearings for Butterfly Valves: Provide thrust bearings to hold the valve disc in the center of the valve seat. No bearings shall be mounted inside the valve body within the waterway. Do not use thrust bearings in which a metal bearing surface on the disc rubs in contact with an opposing metal surface on the inside of the body.

B. Bronze Components in Butterfly Valves: Bronze components in contact with water shall comply with the following requirements:

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Content (Maximum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc</td>
<td>7 percent</td>
</tr>
<tr>
<td>Aluminum</td>
<td>2 percent</td>
</tr>
<tr>
<td>Lead</td>
<td>8 percent</td>
</tr>
<tr>
<td>Copper + Nickel + Silicon</td>
<td>83 percent</td>
</tr>
</tbody>
</table>

C. Actuator Sizing for Butterfly Valves: Actuators shall be sized to produce output torque values as listed in Table 4 of AWWA C504.

D. Port Sizes for Butterfly Valves: For valves 24 inches and smaller, the actual port diameter shall be at least 93 percent of the nominal valve size. For valves larger than 24 inches, the port diameter shall not be more
than 1-1/4 inches smaller than the nominal valve size. The dimension of the port diameter shall not include the thickness of the rubber seat.

E. Corrosion-Resistant Materials in Butterfly Valves: Where AWWA C504 (Subsections 3.5, 3.6, and 3.7) requires "corrosion resistant" material, such material shall be one of the following:

1. Bronze as described above.
2. Type 304 or 316 stainless steel.
3. Monel (UNS N04400).
4. Synthetic nonmetallic material.

F. Seating Surfaces in Butterfly Valves: Seating surfaces in valves having motorized actuators shall be stainless steel or nickel-copper per AWWA C504, Sections 2.2 and 3.5, or nickel-chromium alloy containing a minimum of 72 percent nickel and a minimum of 14 percent chromium.

G. Butterfly Valves Four Inches and Larger, Class 150B: Butterfly valves shall be short body, flanged type, conforming to AWWA C504, Class 150B. Minimum working differential pressure across the valve disc shall be 150 psi. Flanged ends shall be Class 125, ANSI B16.1. Valve shafts shall be Type 304 or 316 stainless steel. Valve shafts shall be stub shaft or one-piece units extending completely through the valve disc. Materials of construction shall be as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Material</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body</td>
<td>Cast Iron or ductile iron</td>
<td>ASTM A48, Class 40, ASTM A126, Class B; or ASTM A536, Grade 65-45-12.</td>
</tr>
<tr>
<td>Exposed body capscrews and bolts and nuts</td>
<td>Stainless Steel</td>
<td>ASTM A276, Type 304 or 316.</td>
</tr>
<tr>
<td>Discs</td>
<td>Cast Iron, ductile iron, or Ni-Resist</td>
<td>ASTM A48, Class 40; ASTM A536, Grade 65-45-12; ASTM A436, Type 1; or ASTM A126, Class B.</td>
</tr>
<tr>
<td>Disc fasteners, seat retention segments, and seat fastening devices</td>
<td>Stainless Steel</td>
<td>ASTM A276, Type 304 or 316.</td>
</tr>
<tr>
<td>Seat Material</td>
<td>Buna-N</td>
<td>None.</td>
</tr>
</tbody>
</table>

H. The valve seat shall be secured to or retained in the valve body.

I. For valves 24 inches and larger, the seat shall be fully adjustable and replaceable while installed in the pipeline and continuously mechanically retained within or onto the valve body. Bolt the valve disc to the stainless steel shaft and the bolts shall be bolted to the stainless steel shaft and disc. Wedge-type fasteners are not acceptable.

J. Valves shall be Pratt, DeZurik Figure 670, or equal.
2.11 BALL VALVES

A. Bronze Ball Valves Two Inches and Smaller: Ball valves, two inches and smaller, for air or water service shall be all bronze (body, ball, stem, and plug ball retainer), ASTM B62. Provide chrome-plated ball. Valves shall have screwed ends (ANSI B1.20.1), non-blowout stems, reinforced Teflon seats, and have plastic-coated lever operators. Valves shall have a pressure rating of at least 600 psi WOG at a temperature of 150 degrees F. Valves shall be Stockham S-216, Lunkenheimer Figure 707, or equal.

B. Rubber Seated Ball Valves, four through 24 inches: Ball valves shall be flanged, conforming to AWWA C507, and the following: The minimum rated working pressure shall be 150 psi. The ball valve design pressure shall be as indicated on the Plans. Flanged ends shall be flat-faced conforming to ANSI B16.1. The manufacturer shall have manufactured tight-closing, rubber-seat ball valves for the specified service for a period of at least six years, and certify that the rubber seat is field adjustable and replaceable.

1. Body: The valve body shall have integral support legs or pads and shall consist of two body end pieces and a center body piece through-bolted and O-ring sealed against leakage.

2. Ball: The valve ball shall be taper-pinned to an upper and lower fitted shaft that is turned, ground, and polished to a 32 microinch or smoother finish per ANSI B46.1.

3. Bearings and Seals: The center section shall be fitted with sleeve-type bearings contained in the body hubs. Bearings shall be self-lubricating, with minimum wall thickness of 1/4 inch. Material shall be Teflon-lined with fiberglass backing. Bearing surfaces shall be isolated from flow by O-ring seals. The ball assembly shall be supported by a two-way thrust bearing assembly consisting of a Type 304 stainless-steel stud and a bronze thrust collar (ASTM B505, Alloy C93200) in a grease-packed cavity.

4. Seats: Valve seats shall be of a synthetic rubber compound. Seats shall be retained in the valve body by mechanical means without retaining rings, segments, screws, or hardware of any kind in the flow stream. Seats shall seal a full 360 degrees without interruption and shall mate with a spherical Type 316 stainless-steel seating surface on the ball. Valve seats shall be field adjustable around the full 360-degree circumference and replaceable without dismantling the operator, ball, or shaft. Where line size permits, seats shall also be capable of being replaced or adjusted without removing the valve from the line. Valves shall be double-seated to allow drip-tight closure in two directions.

5. Manufacturer: Henry Pratt Co., or equal.

6. Materials of construction for ball valves shall be as follows:

<table>
<thead>
<tr>
<th>Component:</th>
<th>Valve body</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material:</td>
<td>Cast Iron</td>
</tr>
<tr>
<td>Specification:</td>
<td>ASTM A126, Class B or ASTM A48, Class 35.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Component:</th>
<th>Ball or Rotor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material:</td>
<td>Cast Iron</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Component:</th>
<th>Shaft and Taper Pins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material:</td>
<td>Stainless Steel</td>
</tr>
<tr>
<td>Specification:</td>
<td>ASTM A276, Type 304 or 316</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Component:</th>
<th>Body Bolts, Studs, and Nuts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material:</td>
<td>Carbon Steel</td>
</tr>
<tr>
<td>Specification:</td>
<td>ASTM A307, Grade B.</td>
</tr>
</tbody>
</table>
Component: Capscrews (internal and external) and lockwashers  
Material: Stainless Steel  
Specification: ASTM A193, Type 316.

Component: Seats (rubber)  
Material: Buna-N  
Specification: None.

2.12 PLUG VALVES

A. Lubricated plug valves shall have semisteel (ASTM A126, Class B) bodies and tapered plugs. Valves shall be enclosed worm-gear operated. Valves shall be lubricated with the manufacturer's recommended and NSF-approved lubricant for water service. Plug coating shall be Teflon or nylon, permanently bonded to the plug. Provide valves with non-inverted, top-entry plugs. Inverted bottom entry plugs shall be of the pressure balanced design.

B. Valves shall be of the regular pattern, unless otherwise shown on the Plans, with bolted glands and resilient packing. The port area for regular pattern plug valves shall be not less than 80 percent of the nominal valve size. The dimensions and drilling of flanges shall conform to ANSI B16.1. The face-to-face dimensions shall conform to ANSI B16.10, unless otherwise shown or specified. Valve pressure rating shall be shown on the Plans. Valves shall be Nordstrom, Christensens, or approved equal. The face-to-face dimensions shall conform to ANSI B-16.10, unless otherwise shown or specified.

2.13 PET COCKS AND DRAIN COCKS

A. Pet Cocks 1/2 Inch and Smaller: Pet cocks shall be all bronze (ASTM B62) or brass (ASTM B16), rated at 125 psi. Provide lever or tee handle operator. Pet cocks shall be Crane Figure 724, Lunkenheimer Figure 478 or 479, or equal.

B. Drain Cocks 1/2 Inch and Smaller: Drain cocks shall be all bronze (ASTM B62) or brass (ASTM B16), rated at 125 psi. Provide lever or tee handle operator. Drain cocks shall be Crane Figure 702, Lunkenheimer Figure 476 or 980, or equal.

2.14 BOLTS AND NUTS FOR FLANGES FOR STEEL PIPING

A. Provide bolts, nuts and gaskets for flanged valves per Section 15000, Piping Schedule and General Piping Requirements.

PART 3 - EXECUTION

3.01 JOINTS

A. Bolt holes of flanged valves shall straddle the horizontal and vertical centerlines of the pipe run to which the valves are attached. Clean flanges by wire brushing before installing flanged valves. Clean flange bolts and nuts by wire brushing, lubricate threads with oil and graphite, and tighten nuts uniformly and progressively. If flanges leak under pressure testing, loosen or remove the nuts and bolts, reseat or replace the gasket, install new bolts and nuts, and retest the joints. Joints shall be watertight.

B. Clean threaded joints by wire brushing or swabbing. Apply Teflon joint compound or Teflon tape to pipe threads before installing threaded valves. Joints shall be watertight.

C. Install grooved-end couplings for valves in accordance with the coupling manufacturer's recommendations. Clean loose scale, rust, oil, grease, and dirt from the pipe and valve grooves before installing coupling. Apply the coupling manufacturer's gasket lubricant to the gasket exterior including
lips, pipe ends, and housing interiors. Fasten coupling alternately and evenly until coupling halves are seated.

3.02 INSTALLING EXPOSED VALVES

A. Unless otherwise indicated in the Plans, install valves with their operating stems vertical.

B. In horizontal pipe runs, install plug valves so the plug rests in a horizontal plane.

3.03 MOUNTING GEAR ACTUATORS

A. The valve manufacturer shall select and mount the gear actuator and accessories on each valve and stroke the valve from fully open to fully closed prior to conducting hydrostatic seat test.

B. For butterfly valves, the gear actuator’s fully open set point shall position the valve disc at precisely 90 degrees open.

3.04 FIELD INSTALLATION OF GEAR ACTUATOR

A. Provide actuator manufacturer’s recommended lubricant in each actuator before commencing field testing.

3.05 VALVE LEAKAGE TESTING

A. Test valves for leakage at the same time that the connecting pipelines are tested. See Section 02676 Pressure Testing of Piping, for pressure test requirements. Protect or isolate any parts of valves, actuators, or control and instrumentation systems whose pressure rating is less than the pressure test. Valves shall show zero leakage. Repair or replace any valves and retest.

3.06 VALVE FIELD TESTING

A. Operate manual valves through ten full cycles of opening and closing. Valves shall operate from full open to full close without sticking or binding. If valves stick or bind, repair or replace the valve and repeat the tests.

B. Gear actuators shall operate valves from full open to full close through ten cycles without binding or sticking. The pull required to operate handwheel- or chainwheel-operated valves shall not exceed 80 pounds. The torque required to operate valves having two inch AWWA nuts shall not exceed 150 foot pounds. If actuators stick or bind or if pulling forces and torques exceed the values stated previously, repair or replace the actuators and repeat the tests. Fully lubricate operators in accordance with the manufacturer's recommendations prior to operating.

3.07 VALVE WARRANTY

A. The ball valve manufacturer shall warrant its product to be free from defects in materials, workmanship, and performance for valves incorporated into the work for six years from the date of delivery to the worksite of the final ball valve to be incorporated into the work.

B. The plug valve manufacturer shall warrant its product to be free from defects in materials, workmanship, and performance for valves incorporated into the work for six years from the date of delivery to the worksite of the final plug valve to be incorporated into the work.

C. The butterfly valve manufacturer shall warrant its product to be free from defects in materials, workmanship, and performance for valves incorporated into the work for two years from the date of delivery to the worksite of the final butterfly valve to be incorporated into the work.
D. The gate valve manufacturer shall warrant its product to be free from defects in materials, workmanship, and performance for valves incorporated into the work for two years from the date of delivery to the worksite of the final gate valve to be incorporated into the work.

3.08 VALVE ACTUATOR WARRANTY

A. The valve actuator manufacturer shall warrant its product to be free from defects in materials, workmanship and performance for actuators incorporated in the work for a period of five years from the date of recording the Notice of Completion. Upon notice by the Water Authority, any damage or defect found during the warranty period shall be promptly repaired or replaced by the manufacturer at no cost to the Water Authority.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes materials and installation of air and vacuum valves and air-release valves for water service.

B. Valve manufacturers shall have a minimum of five years of recent continuous product history in the USA waterworks industry.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 09900 Painting and Coating

B. Section 15100 Valves

C. Section 15190 Equipment, Piping, Duct and Valve Identification

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Society for Testing and Materials.


A276 Specification for Stainless and Heat-Resisting Steel Bars and Shapes.

1.04 SUBMITTALS

A. Submit manufacturer's catalog data. Show dimensions, materials of construction by ASTM reference and grade, and coatings.

PART 2 - MATERIALS

2.01 VALVE TAGGING AND IDENTIFICATION

A. Provide valve identification per Section 15190, Equipment, Piping, Duct and Valve Identification.

2.02 COATING

A. Coat valves located above ground or in vaults and structures in accordance with Section 09900, Painting and Coating, System No. 10 or System No. 11. Apply prime coat at the place of manufacturer. Match color of finish coat with the color of the adjacent piping. Do not coat stainless-steel pieces.

2.03 LINING

A. Coat interior surfaces of cast-iron valves at the place of manufacture per Section 09900, Painting and Coating, System No. 7. Do not coat seating areas and plastic, bronze, stainless steel, or other high alloy parts.
B. Test the valve interior linings at the factory with a low-voltage (22.5 to 80 volts, with approximately 80,000-ohm resistance) holiday detector, using a sponge saturated with a 0.5 percent sodium chloride solution. The lining shall be holiday free.

2.04 VALVE DESIGN AND OPERATION

A. Air-release valves for water service shall function to slowly release pockets of air which accumulate at high points in piping systems. Valves larger than 3/4 inch shall have a float-actuated compound lever with linkage mechanism to release air. Float shall withstand an external pressure of 1,000 psig without collapsing.

B. Air-release valves two inches in size shall incorporate a body with flanged top cover, screened mushroom-type cap outlet, and replaceable orifice and a synthetic rubber needle or disc actuated by the float and linkage mechanism. Top cover shall include a 1/2 inch threaded outlet with bronze plug. Body shall include a 1/2 inch threaded drain outlet near the bottom with a bronze plug.

C. Air and vacuum valves for water service shall have a float assembly and large venting orifice to exhaust large quantities of air from pipelines when being filled and to admit large quantities of air when pipelines are being drained. Valve shall have a body with a flanged top containing the air-release orifice. The float shall rise with the water level in the valve body to close the orifice by sealing against a synthetic rubber seat. Float shall be protected by a baffle to prevent premature closing and shall withstand an external pressure of 1,000 psig without collapsing. Do not use designs having levers and weights attached to the floats. Float shall have a one-piece guide rod extending out of the bottom end to engage the guide bushings in the valve body at all times.

D. Air and vacuum valves larger than four inches shall have a one inch threaded drain outlet with bronze plug near the bottom of the valve body and a two-inch threaded outlet with bronze plug on the side of the valve body above the minimum water level in the valve which forces the float against the valve seat. The valve outlet shall have a protective steel hood to prevent entry of foreign material.

E. Remove the bronze plug and attach a stainless steel ball valve to the threaded drain outlet as shown on the Plans. Ball valve size shall be 1/2 inch or one inch to match the drain outlet. Ball valve shall be 316 stainless steel, Apollo 76-103, Apollo 76-105, or equal.

F. Combination air release-vacuum valves, one inch through six inches in size shall incorporate a body with a flanged top cover. The valve shall house a float and lever assembly that activates a plug within a large venting orifice to exhaust air when pipelines are being filled, and to admit air when pipelines are being drained. The float and lever assembly shall rise with the water level in the valve body to close the large orifice by sealing the plug against a synthetic rubber seat. The float shall be protected by a baffle to prevent premature closing and shall withstand an external pressure of 1,000 psig without collapsing. When the valve is pressurized, the plug shall remain sealed against the large venting orifice, and the float and lever assembly shall activate a needle or button to open or seal a small orifice within the plug to release accumulated air.

2.05 MATERIALS OF CONSTRUCTION

A. Materials of construction for air-release valves for water service shall be as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Material</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body and Cover</td>
<td>Cast Iron</td>
<td>ASTM A126, Grade B</td>
</tr>
<tr>
<td>Float</td>
<td>Stainless Steel</td>
<td>AISI Type 316, ASTM A240 or A276</td>
</tr>
<tr>
<td>Linkage, orifice air-release</td>
<td>Stainless Steel</td>
<td>AISI Type 316</td>
</tr>
<tr>
<td>Needle</td>
<td>Buna-N</td>
<td>---</td>
</tr>
</tbody>
</table>
B. Materials of construction for air and vacuum valves for water service shall be as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Material</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body and Cover</td>
<td>Cast Iron</td>
<td>ASTM A48, Class 30</td>
</tr>
<tr>
<td>Float, Guide, Rod, Guide Bushings</td>
<td>Stainless Steel</td>
<td>AISI Type 316, ASTM A240 or A276</td>
</tr>
<tr>
<td>Seat</td>
<td>Buna-N</td>
<td>---</td>
</tr>
</tbody>
</table>

C. Materials of construction for combination air release-vacuum valves for water service shall be as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Material</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body and Cover</td>
<td>Cast Iron</td>
<td>ASTM A126, Grade B</td>
</tr>
<tr>
<td>Needle or Button, Seat</td>
<td>Buna-N</td>
<td>-</td>
</tr>
<tr>
<td>Float, Lever Assembly, All Other Internal Parts</td>
<td>Stainless Steel</td>
<td>ASTM A240, A276, SAE 30303</td>
</tr>
</tbody>
</table>

2.06 AIR-RELEASE VALVES

A. Air-Release Valves, two Inches, Class 150 lb flange: Valves shall have an operating pressure rating of 150 psi. Minimum orifice size shall be 3/8 inch. Valves shall be APCO 200, Val-Matic Model 45, or equal.

B. Air-Release Valves, two-Inches, Class 300 lb flange: Valves shall have an operating pressure rating of 300 psi. Minimum orifice size shall be 7/32 inch. Valves shall be APCO 205, Crispin Type "N," Val-Matic Model 50, or equal.

2.07 AIR AND VACUUM VALVES

A. Air and Vacuum Valves, four through 16 inches, Class 150 lb flange: Valves shall have an operating pressure of 150 psi. Provide steel hood above the top cover and orifice. Valves shall be APCO Series 150, Val-Matic Models 104 through 116, or equal.

B. Air and Vacuum Valves4 through 16 inches, Class 300 lb flange: Valves shall have a flanged body and an operating pressure rating of 300 psi. Provide steel hood above the top cover and orifice. Valves shall be APCO Series 150, Val-Matic Models 104 through 116, or equal.

2.08 COMBINATION AIR RELEASE - VACUUM VALVES

A. Combination air valves, one through six inches, Class 150 lb flange: Valves shall have an operating pressure of 150 psi. Valves shall be APCO Series 143 through 150, Val-Matic Models 201 through 204, or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Clean flanges by wire brushing before installing flanged valves. Clean flange bolts and nuts by wire brushing, lubricate threads with oil and graphite, and tighten nuts uniformly and progressively. If flanges leak under pressure testing, loosen or remove the nuts and bolts, reseat or replace the gasket, install new bolts and nuts, and retest the joints. Joints shall be watertight.

B. Clean threaded joints by wire brushing or swabbing. Apply Teflon joint compound or Teflon tape to pipe threads before installing threaded valves. Joints shall be watertight.
3.02 VALVE PRESSURE TESTING

A. Test valves at the same time that the connecting pipelines are pressure tested. Protect or isolate any parts of valves, operators, or control and instrumentation systems whose pressure rating is less than the test pressure.

3.03 VALVE WARRANTY

A. The air and vacuum valve manufacturer shall warrant its product to be free from defects in materials, workmanship, and performance for valves incorporated into the work for two years from the date of delivery to the worksite of the final air and vacuum valve to be incorporated into the work.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes materials, installation and testing of electric motor actuators for valves six inch and larger in accordance with AWWA C540, except as modified below. The electric motor actuator shall include any necessary intermediate gearing between the electric actuator and the valve to which it is attached.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01400 Quality Control
B. Section 09900 Painting and Coating
C. Section 15100 Valves

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Water Works Association.
B. C540 Power Actuating Devices for Valves and Sluice Gates.

1.04 SUBMITTALS

A. Manufacturer's catalog data showing motor actuator parts and materials of construction, referenced by AISI, NEMA, ASTM, SAE, or CDA specification and grade. Show motor actuator dimensions and weights. Show coatings.
B. Motor data including nameplate data, insulation type, output torque, voltage, phases, frequency, current at running torque and locked rotor, duty rating, and open/close travel time.
C. Open/close travel times meeting the valve travel times shown or specified. The open/close travel time is defined as the time required for the valve to travel from close-to-open or open-to-close. A cycle is defined as close to open and back to close.
D. Electrical schematic drawings and physical wiring diagrams showing all components.
E. Certified factory performance test records, including written cycle test results as specified herein.
F. Drawings of the electrical components enclosure (physical layout in three dimensions or views).
G. Information showing the relationship between the operator output torque and torque limit switch settings.
H. Complete specifications and ordering information for replacement motors.
I. Warranty certification, from actuator manufacturer, that actuator meets or exceeds all parts of this specification.
J. Operation and maintenance manuals containing:
   1. Complete installation instructions.
   2. Operating and maintenance instructions.
   3. Complete parts list.
   4. Part change out instructions.
   5. Theory of operation of the actuator and intermediate gearing.
   6. Expanded parts drawings, showing all mechanical and electrical parts.
   7. Electrical schematic drawings and physical wiring diagrams showing all components.
   8. Drawings of the electrical components enclosure (physical layout in three dimensions or views).
   9. List of recommended spare parts.
   10. List of special tools for installation, maintenance, and adjustments.
   11. Lubrication guide with list of recommended lubricants.

K. Copies of factory training certification, from the actuator manufacturer, for any maintenance or installation technicians. Training certifications shall be specific to the models installed. Certificates shall be approved by the Engineer before technicians are authorized to perform any work on the valve actuators.

PART 2 - MATERIALS

2.01 MANUFACTURERS

A. Actuators designated on the Plans or in the specifications as “Intelligent Electric Motor Actuators” shall be Limitorque Accutronix MX, or approved equal. Actuators designated on the Plans or in the specifications as “Non-Intelligent Electric Motor Actuators,” or with no special designation, shall be Limitorque L120, or approved equal.

B. Actuator manufacturers shall have a minimum of ten years experience manufacturing and installing valve actuators.

C. Actuator must have a minimum maintenance history of 50 units, of the same model and option package as the submitted actuator, that have each functioned in a field installation for a period of one year without defect or malfunction. Valve actuator manufacturer shall provide complete documentation to meet this requirement, including contact names and telephone and fax numbers that can verify the field installations. Acceptance of the validity of submitted maintenance history is solely at the discretion of the Water Authority.

2.02 ACTUATOR IDENTIFICATION

A. Identify electric motor actuators by model number and serial number shown cast or molded onto the actuator body or on a permanently attached plate in raised letters.

2.03 GEARED OPERATORS
A. Geared valve operators shall conform to Section 15100, Valves.

B. Intermediate Geared Operators.
   1. Provide intermediate operators of spur, helical, or bevel gears, between the new electric motor actuator and the new or existing geared valve operators, if needed to provide the specified open/close time, and to provide proper operation of the valve. The intermediate geared operators shall be designed with bearings suitable for adapting to an electric actuator. Operators designed with bushings are not permitted.
   2. Intermediate geared operators shall be enclosed, oil or grease lubricated, with seals provided on shafts to prevent entry of dirt and water into the operator. Intermediate geared operators do not need a dial indicating the position of the valve.
   3. Intermediate geared operators shall be of the totally enclosed design, so proportioned as to permit operation of the valve under full differential pressure equal to the pressure rating of the valve, with a maximum input of 150 foot-pounds on the operating shaft. Intermediate geared operators shall be oriented to operate with valve stem and electric actuator as directed by the Engineer.
   4. Support gear shaft at each end by ball or tapered roller bearings. Provide reduction gearing to meet maximum torque and pull design requirement. The reduction gearing shall run in a proper lubricant.
   5. Intermediate geared operators shall open valves by turning counterclockwise.

C. Handwheel
   1. Provide a handwheel for manual operation with arrow to indicate "open" rotation. The handwheel shall not rotate during motor operation, and operation of the handwheel shall not cause the motor to rotate. When in manual operating mode, the actuator shall remain in this mode until the motor is energized, at which time the actuator will automatically return to electric operation. Movement from motor operation to handwheel operation shall be accomplished by a positive, padlockable declutching lever, which mechanically disengages the motor and related gearing. Friction type declutch mechanisms are not acceptable. Size the handwheel for a maximum pull of 50 pounds under full differential pressure at any point through valve travel, and including seating or unseating.

2.04 MOTORS FOR ELECTRIC ACTUATORS

A. Provide totally enclosed, high torque, non-ventilated single phase, or three phase motors, suitable for the facility electrical service as shown on the Plans. The NEMA service factor rating shall not be used in rating the motors for the maximum load conditions.

B. Provide motors with Class F or H insulation, specifically designed for valve actuation service, and rated for continuous duty operation and 100 start/stops per hour without overheating. Heat rise after 100 start/stops in an hour shall be less than 50 degrees C. Heat rise after three full consecutive valve cycles shall be less than 50 degrees C. If Travel Time requirements would cause the three-cycle test to extend beyond 60 minutes, limit the test to 60 continuous minutes.

C. Provide motor output capacity sufficient to open or close the valve against the maximum differential pressure when the voltage is 10 percent above or below normal at the specified service conditions.

D. Motor bearings shall be of the anti-friction type, and permanently lubricated.
E. Provide overload protection by one overload relay in each ungrounded conductor with automatic resetting capability and two automatically resetting thermal overload sensors placed in the motor windings and accessible through the motor end bell.

F. For ease of motor or gear replacement, the motor shall be an independent sub-assembly of the actuator power unit such that the power gearing shall not be an integral part of the motor assembly.

G. If replacement motors or motor assemblies for use in the electric actuator are not available to the Water Authority directly from a motor manufacturer, supply spare electric motors or motor assemblies so the Water Authority has immediate access to spare motors. At the time electric actuators are delivered to the jobsite, Contractor shall provide the Water Authority with one spare motor or motor assembly for each size or style of motor supplied for this project.

2.05 ACTUATOR TORQUE REQUIREMENTS

A. Provide actuator with rated output torque at least one and one half times the maximum torque required to operate the valve at any position, including seating and unseating conditions and neglecting hammer-blow effect.

B. Maximum torque requirement is defined as the torque required at the most severe operating conditions, including maximum differential pressure across the valve, and maximum mechanical friction or other restrictive conditions inherent in the valve assembly.

C. Actuator maximum torque shall be calculated with the applied voltage 10 percent below the nominal motor voltage rating.

D. Coordinate with the valve manufacturer to ensure that the motor actuator stall torque output does not exceed the torque limits of the valve operating stem or shaft.

E. The differential pressure across the valve is defined as the pressure rating of the valve, or as specified herein.

F. Except as specified otherwise, the maximum line velocity for torque calculations shall be based on the design flow rate as indicated on the Plans.

G. The line fluid temperature range shall be 40 degrees F to 100 degrees F.

2.06 ELECTRICAL CHARACTERISTICS

A. Operating Speed and Indication

1. Design the actuator to move valves from fully closed to fully open in the time specified for each valve, with a tolerance of plus or minus 2 percent. Actuator shall maintain specified travel times during a plus or minus 10 percent fluctuation in voltage. Where valve travel times are not shown or specified, for valves sized 36 inches and smaller, valve travel time shall be not less than six minutes. For valves larger than 36 inches, valve travel time shall be not less than 20 minutes.

2. Design valve actuators for open/close operation and continuous modulating service to regulate flows. Actuator control will be performed by an outside control source, unless specifically stated to the contrary elsewhere in the specification.

3. The actuator shall have a built-in device that allows the motor to reach full speed before engaging the valve load. This hammer blow feature shall be engaged if the actuator is in handwheel or motor operation.
B. Actuator Housing

1. The housing for the actuator motor and electrical components shall be NEMA 4 or NEMA 6.

2. The housing for the electrical components, limit switches, and torque switches shall consist of a hinged or otherwise mechanically attached cover with captive hardware which allows ready access to components and keeps the cover easily accessible without interfering with the workspace and preventing accidental damage to the cover if dropped.

3. Removal of fuses and switch adjustments shall be accomplished without necessitating removal of other components within the enclosure for ready access.

4. Enclosures shall have at least two 1-1/4 inch minimum NPT threaded hubs for conduit entry.

C. Power Transmission

1. Provide the actuator with an internal, multiple reduction power gearing unit, consisting of spur or helical gears and worm gearing.

2. Provide a self-locking worm gear set in the drive train to maintain valve position.

3. Provide the spur or helical gearing and worm of hardened alloy steel, and the worm gear of alloy bronze. Manufacture all power gearing accurately.

4. Non-metallic, aluminum, or cast gearing shall not be allowed.

5. Use anti-friction bearings with caged balls or roller throughout.

6. All rotating power train components are to operate immersed in grease or oil with provisions for inspection and re-lubrication without disassembly.

7. Lubricants shall be suitable for ambient conditions of minus 20 degrees F to 150 degrees F. Adequate seals shall be provided on all shafting.

8. Noise generated by the actuator shall not exceed 72 dBA at all times within a three-foot radius.

9. The design shall be such as to permit the gear case to be opened for inspection or disassembled without releasing the stem thrust or taking the valve out of service.

2.07 NON-INTELLIGENT ELECTRIC MOTOR ACTUATORS

A. General Design

1. Include as one integral assembly, the motor, internal reduction gearing, position limit switches, torque switches, travel limit switches, position indicator, declutch lever, handwheel, reversing starter and push button controls.

2. Include with each reversing starter four auxiliary contacts, two each for normally open and normally closed. The starter shall have a provision to add additional contacts in future.

3. All actuator wiring shall be routed internally within the actuator except for external power source wire and external control wiring originating from a control panel or source, and terminating at the electrical enclosure of the actuator.
B. Limit Switches

1. Furnish motor actuators with limit switches that provide remote indication at end of travel in each direction, in addition to the limit switches used to stop the motor at the electrical limit of travel in each direction.

2. Limit switches shall be individually adjustable, allowing for trip points from fully open to fully closed positions of valve travel. Limit switches shall not be subject to breakage or slippage due to over-travel.

3. The limit switches shall operate while the actuator is in manual or in motor operation.

4. Design limit switches to permit visible verification of switch position without disassembly of limit switch.

5. Provide limit switch gearing of the intermittent type, made of bronze, steel or stainless steel, grease lubricated, and totally enclosed to prevent dirt and foreign matter from entering the gear train.

6. Provide position limit switch contacts rated for 600 volts per NEMA Standard ICS 2-125, heavy duty, and capable of interrupting at least two-ampere inductive load at 125 volts DC or five-ampere inductive load at 120 volts AC.

7. The actuator shall have 16 contacts, four contact/four rotor type, all of the same basic design.

8. Provide limit switch contacts that are convertible between N/O and N/C. Limit switch actuating gearing shall be maintenance free and designed for a ten-year useful life.

C. Torque Switches

1. Equip actuators with a torque switch that shall interrupt the control circuit in both the opening and closing directions when valve torque overload occurs.

2. Contacts shall be silver plated or solid silver.

3. Provide torque switch with independently adjustable, graduated indicators for adjustment of interrupting torque in both open and close directions of travel.

4. To prevent hammering, the torque switch shall not re-close until the valve is moved in the opposite direction. Include with the torque switch a positive means to limit adjustability so as not to exceed the actuator output torque capability.

5. Provide activating spring pack of the Belleville spring design.

6. Torque switch design shall permit visible verification of switch position without disassembly.

7. Provide metal housing for torque switch contacts, for long life and durability.

8. Provide torque switch contacts rated for 600 volts per NEMA Standard ICS 2-125, heavy duty, and capable of interrupting at least two-ampere inductive load at 125 volts DC or five-ampere inductive load at 120 volts AC.

D. Space Heaters
1. Provide space heaters in the electrical compartment(s) that are properly sized to prevent condensation within the actuator.

E. Actuator Status and Position Indication

1. Supply actuator with open and close status lights; non-latching open and close pushbuttons or non-latching switches; and other devices as shown on the Plans.

2. Status lights shall be red color for “closed” and green color for “open” positions. Only the green light shall be illuminated at the open limit position; only the red light shall be illuminated at the closed limit position; neither indicator shall be illuminated at intermediate positions.

3. Do not include Hand/Off/Auto type selector switch or a Stop switch.

4. Provide a position transmitter for remote position indication. The transmitter shall be based upon a rotary variable differential transformer and driver demodulator design, or other design using roto-reactance or opto-mechanical principles, which will eliminate “dead spots” caused by mechanical friction between parts or burn-in. Potentiometers shall not be acceptable as sensors for position indication.

5. The output signal from the internal position transmitter shall be a 24 volt DC, 4-20 milliamp DC signal, sourced by the actuator, and proportional to position.

6. The position transmitter shall be able to source the entire 20 milliamp signal into a 750 ohm impedance.

7. The unit shall contain zero and span adjustments for calibration of the transmitter with a maximum error of plus or minus two percent. The span shall be adjustable such that a four-milliamp signal can be obtained to indicate the valve is closed, and a 20 milliamp signal can be obtained to indicate the valve is fully open. The two percent maximum error shall include, repeatability, linearity, and positional accuracy throughout the entire range of motion.

8. Provide isolated contacts for "motor run" indication.

9. Provide a mechanical position dial indicator graduated in 25 percent increments in step with valve position both in motor and manual operation. The unit shall be of metallic design with associated metallic gearing and viewable with enclosure closed and secured.

F. Electrical Connections

1. Terminal facilities for connection to motor leads, switches, position transmitter, and heating elements shall be provided in readily accessible terminal compartments.

2. Each terminal compartment shall be large enough to allow easy routing and termination of fifteen 12-AWG conductors.

2.08 INTELLIGENT ELECTRIC MOTOR ACTUATORS

A. General Design

1. Include as one integral assembly, the motor, internal reduction gearing, position limit switches, torque switches, travel limit switches, position indicator, declutch lever, handwheel, solid state reversing starter and push button controls. The actuator shall be of a modular design, allowing rapid replacement of faulty modules or sub-sections.
2. The actuator shall be an intelligent, microprocessor-based design.

3. All calibration and set-up features shall be available from a non-intrusive front panel, accessible without requiring the removal of any covers or the use of special tools.

4. Actuator shall be suitable for service within the temperature range from minus 30 degrees C to plus 70 degrees C.

5. The electric motor shall be electrically connected to the actuator through use of a plug-in electrical connector. The motor shall be removable without draining oil or grease from the gearbox.

B. Communication with Actuator

1. Actuator shall support two-wire Foundation-Fieldbus communication, and allow access to every programmable feature through this interface. Foundation-Fieldbus communication shall be accomplished through a card or module internal to the actuator.

2. Actuator shall be configurable for remote step-mode control, using 120-VAC or 24 volt DC command lines.

3. Actuator shall supply 120-VAC or 24-VDC control power for remote control, and shall accept external 120-VAC or 24-VDC power for remote control. Internal actuator power supplies shall be automatically protected against overcurrent or short circuit conditions.

4. Actuator shall allow programming of all programmable features via front-panel switches and local display.

5. Actuator shall allow access to all programmable features via a laptop computer connected directly to the actuator. If software other than a terminal emulator is required for access, then the software and a cable shall be provided at the time of delivery.

C. Local/Remote Interface

1. Actuator shall have a local interface/display screen capable of displaying at least 32 alphanumeric characters and a 0 percent to 100 percent bar graph display for valve position readout. All text messages or displays shall be in English.

2. Actuator shall have a local HAND-OFF-AUTOMATIC mode control switch, and a local OPEN-OFF-CLOSE position command switch. The HOA switch shall be lockable in any position by using a standard padlock.

3. Local and remote programming interface shall be protected by user-selectable password protection for all programmable features.

4. The local control switches shall not penetrate the actuator enclosure, and shall electrically isolate the operator from any internal voltages.

5. The OPEN-OFF-CLOSE switch shall be user-configurable for maintained or inching control.

6. Four latched contacts shall be provided for remote indication of valve position. These contacts shall be 1-NO and 1-NC contact for open or closed positions. These contacts shall be programmable for operation at any position between full open and full closed positions, or shall be programmable to indicate any of the following: mid-travel, local mode, over torque, motor over temperature, manual
operation, remote mode, valve moving, close torque switch, open torque switch, hardware failure, or valve jammed. These contacts shall be rated 250-VAC/30-VDC, 5 amps.

D. Position/Limit/Torque Sensors

1. Actuators shall use non-contact type absolute position encoders, capable of at least 15-bit resolution. Position encoders shall sense actual valve position at all times, during electrical or handwheel operation, with or without applied electrical power, and without the use of batteries. The encoder maximum error shall be less than 2 percent and shall include, repeatability, linearity, and positional accuracy throughout the entire range of motion.

2. Open and close valve travel-limit positions shall be a function of the absolute position encoder, shall be stored in permanent, non-volatile memory, and shall be easily adjustable from the local or remote interface.

3. Torque shall be measured with a non-mechanical, purely electronic sensor. The motor-torque limit shall be adjustable over 40 percent to 100 percent of design torque in 1 percent increments.

4. The motor shall automatically de-energize if an over-torque condition is sensed. Torque limit protection shall automatically adjust for initial valve un-seating, or for programmed torque seating of valves. A valve movement in the opposite direction of the over torque move shall reset the torque limit protection.

5. The actuator shall offer, as an option, a 4-20 mA analog output signal that is proportional to valve position. The sensor for this signal shall be the non-contact type absolute position encoders and conform to the accuracy requirements in Part 2.07, Paragraph E, Item 7 of this section.

E. Intelligent Control Module

1. The actuator control module shall be of a modular design, with replaceable circuit boards for troubleshooting. The control module shall be entirely housed within the actuator, and shall be easily accessible for maintenance.

2. The control circuit boards or modules shall be connected with plug-in card connectors or wiring plugs.

3. The control module shall include a solid-state motor reversing circuit. Mechanical reversing contactors are not acceptable. Failure of the solid-state motor reversing module shall not result in unintended motor operation.

4. The control module shall include any necessary internal protection fuses. No external or accessory fuses shall be required for full protection of the motor or control electronics package.

5. Use of the solid-state motor reversing circuit shall not affect actuator performance, or degrade communication between the actuator and remote control equipment.

6. The control package shall be capable of 300 starts per hour for modulating service.

7. All control transformers shall include vacuum impregnated coils, and have dual primary fuses.

8. The control module shall include an automatic directional reversal delay, to prevent current surges from rapid motor reversal.
9. The control module shall incorporate an automatic phase-correction circuit to correct motor rotation errors due to incorrect site wiring.

10. The control module shall include an automatic phase-failure detection circuit that shall disable motor rotation if a phase-loss is detected.

11. The control module shall allow both Foundation-Fieldbus, and step-mode control of the actuator.

12. The control module shall offer two additional non-latching NO relay outputs, and one additional NC relay output. All relay outputs shall be rated at 120-VAC, five-Amps. These relay outputs shall be user-configurable to offer indications of any of the following conditions: pre-programmed valve position, over torque, HOA in local mode, HOA in off mode, handwheel operation, motor over temperature, open torque switches, closed torque switches, hardware failure, and valve moving.

13. Terminals shall be included within the actuator control wiring compartment to power the control module from an external plus 24 volt DC source.

14. The control module shall be designed to prevent undesired valve operation in the event of an internal fault or erratic command signal. Fault detection by the control module, or failure of the control module, shall not energize the motor.

15. All calibration of the actuator shall be possible without removing any covers, shall not require any special tools, and shall be accomplished by answering simple questions displayed on the operator display.

16. The control module shall accumulate and store diagnostic information about the performance of the actuator. This information shall include motor, position encoder, and contactor performance, cycle time, handwheel operations, actuator identification, output turns, and a torque profile of the valve baseline stroke and the last valve stroke for comparison. All diagnostic information shall be displayed on the local operator interface panel, and shall be available over the Foundation-Fieldbus communication link.

F. Power/Control Wiring

1. All customer connections shall be located in a compartment that is separate from the control circuits and other internal spaces. Accessing the wiring compartment shall not require opening any other actuator compartments.

2. The wiring connections compartment shall contain a suitable number of screw-type terminals to allow connection of step-mode controls or Foundation-Fieldbus control wiring, and the control wiring shall be physically separated from the power wiring.

2.09 DRIVE SLEEVE

A. Provide a drop-in stem nut held in place with a snap ring, torque bushing, or threaded locknut and keyway which couples the actuator to the intermediate geared operator or valve stem and provides a versatile means of disassembling the actuator from the operator or valve.

2.10 FACTORY TESTING OF MOTOR ACTUATOR

A. Test each actuator prior to shipment in accordance with AWWA C540. Submit certified test reports of performance. The application torque used during the testing shall be the maximum torque required to open or close the valve at any position including seating and unseating conditions.
PART 3 - EXECUTION

3.01 ATTACHING ELECTRIC ACTUATORS
A. Actuators shall be maintained and protected from damage according to the manufacturer’s recommendations at all times prior to commissioning. Electrical enclosures and electrical components found with condensation or condensation related damages shall be replaced at no cost to the Water Authority prior to acceptance of the work.

B. The valve manufacturer shall mount the electric motor actuator and accessories on each valve and stroke the valve prior to shipment. Adjust limit switch positions, valve position transmitter and torque switches.

C. The valve manufacturer shall provide, install and calibrate each valve actuator on the specified valve(s). The valve manufacturer shall only employ skilled workers that are factory certified by the actuator manufacturer to install and calibrate each valve actuator. Actuator mounting arrangements shall facilitate operation and maintenance and shall be determined by the valve manufacturer, unless indicated otherwise on the Plans or directed by the Engineer. Provide certification that the valve actuators have been installed and adjusted by the valve manufacturer. The actuator access cover shall be orientated to prevent the cover from falling into the workspace, causing injury to personnel.

3.02 PAINTING AND COATING
A. Coat exterior metal surfaces of electric motor actuators and intermediate geared operators in accordance with Section 09900, Painting and Coating. Provide rust inhibiting inorganic zinc-rich primer and intermediate and finish coats of high-build epoxy recommended by the manufacturer of the equipment.

3.03 FIELD TESTING OF ELECTRIC MOTOR ACTUATORS
A. Only maintenance technicians that are certified by the actuator manufacturer shall be employed to perform any field-testing, adjustment, or set-up of the valve actuator.

B. Test motor actuators as installed by measuring the current drawn (in amperes) by each motor for unseating, seating, and running conditions. The measured current shall not exceed the current measurement recorded during the factory performance test by more than five percent.

C. If the measured current drawn exceeds the above value, provide a larger motor of the same type or a gear drive or adjust the actuator so that the measured amperage does not exceed the value.

D. Assure that limit switches are placed at their correct settings. Open and close valves twice and assure that limit switches function. Verify the position transmitters and any other information being developed in the actuator complies with requirements contained within this specification or listed on the plans.

E. The electric motor actuator manufacturer shall be available at the work site to check the installation, supervise the startup, and conduct field-testing and adjustment of the equipment. Provide factory-authorized formal training in the operation and maintenance of the equipment to Water Authority personnel, such that the Water Authority personnel are qualified by the submitted equipment manufacturer to maintain their equipment. Documentation of this qualification shall be provided as part of the training package.

3.04 ELECTRIC MOTOR ACTUATOR WARRANTY
A. The electric motor actuator manufacturer shall warrant its product to be free from defects in materials, workmanship and performance for actuators incorporated in the work for a period of five years from the date of recording of the Notice of Completion. Upon notice by the Water Authority, any damage or
defect found during the warranty period shall be promptly repaired or replaced by the manufacturer at no cost to the Water Authority.

B. In emergency situations, if warranty service is not immediately available from the Vendor/Supplier or the Manufacturer, the Water Authority will perform repairs to re-establish proper operation of the actuator and valve. All defective parts returned by the Water Authority shall be replaced with new parts. If the Water Authority replaces the entire actuator for cause, the Vendor/Supplier or the Manufacturer shall repair or replace the entire actuator.

C. Maintenance or repair work performed by the Water Authority during the warranty period shall not be cause for voiding the warranty.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section describes materials and installation of flexible gasketed sleeve-type compression pipe couplings, mechanical-type couplings, and joint harnesses, in accordance with AWWA C219, as modified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02653 Steel Pipe
B. Section 02676 Pressure Testing of Piping
C. Section 09900 Painting and Coating
D. Section 15000 Piping Schedule and General Piping Requirements
E. Section 15144 Pipe Hangers and Supports
F. Section 16640 Cathodic Protection

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Society for Testing and Materials
   A36 Specification for Structural Steel.
   A53 Specification for Pipe, Steel, Black and Hot Dipped, Zinc-Coated Welded and Seamless.
   A193 Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
   A194 Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.
   A283 Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
   A510 Specification for General Requirements for Wire Rods and Course Round Wire, Carbon Steel
   A512 Specification for Cold-Drawn Buttweld Carbon Steel Mechanical Tubing.
   A536 Specification for Ductile Iron Castings.

B. American Water Works Association
   C105 Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids.
C219 Bolted, Sleeve-Type Couplings for Plain-End Pipe.

C606 Standard for Grooved and Shoulder-type Joints.

M-11 Steel-Pipe Guide for Design and Installation.

1.04 SUBMITTALS

A. Manufacturer's catalog data on mechanical and flexible pipe couplings. Show manufacturer's model or figure number for each type of coupling or joint for each type of pipe material for which couplings are used. Show coatings.

B. Manufacturer's recommended torques to which the coupling bolts shall be tightened for the flexible gasketed sleeve-type compression pipe couplings.

C. Show materials of construction by ASTM reference and grade. Show dimensions.

D. Show number, size, and material of tie rods and lugs for each thrust harness on the project.

E. Provide results of hydrostatic pressure testing verifying that proof of design testing has been performed.

PART 2 - MATERIALS

2.01 STEEL FLEXIBLE PIPE COUPLINGS

A. Steel couplings shall have middle rings made of steel conforming to ASTM A36, A53 (Type E or S), or A512 having a minimum yield strength of 30,000 psi. Follower rings shall be malleable iron (ASTM A47, Grade 32510), ductile iron (ASTM A536), or steel (ASTM A108, Grade 1018, or ASTM A510, Grades 1018 or 1021). Minimum middle ring length shall be five inches for pipe sizes 3/4 inch through 4-1/2 inches; 7 inches for pipe sizes 5 through 24 inches; and 10 inches for pipe sizes larger than 24 inches.

B. Sleeve bolts shall have a minimum yield strength of 40,000 psi, an ultimate strength of 60,000 psi, and shall conform to AWWA C111.

C. Steel follower rings shall be cast, forged, or hot rolled in one piece. Do not use rings fabricated from two or more shapes.

D. Wall thickness of sleeve shall be at least that specified for the size of pipe in which the coupling is to be used.

2.02 JOINT HARNESSSES

A. Bolts or stud material shall conform to ASTM A307, Grade B. Nuts shall conform to ASTM A563, Grade A, heavy hex. Lug material shall conform to ASTM A36; ASTM A283, Grade B, C, or D; or ASTM A285, Grade C. Lug dimensions for steel pipe shall be as shown in AWWA Manual M11 (1989 edition), Figure 13-17. Lugs shall be Type P for pipes six through ten inches and Type RR for pipes 12 inches or larger.

B. The design pressure for the tie bolts is the greater of 0.433 psi multiplied by the design hydraulic grade line minus invert elevation or 150 psi.

C. Provide washer for each nut where harness is shown to be electrically insulated. Washer material shall be the same as the nuts. Minimum washer thickness shall be 1/8 inch.

2.03 FLEXIBLE PIPE COUPLINGS FOR PLAIN END STEEL PIPE

A. Flexible pipe couplings for steel pipe shall be steel, Dresser Style 38, Smith-Blair Type 411, Baker Series 200, or equal.
2.04 TRANSITION COUPLINGS

A. Transition couplings for connecting different pipes having different outside diameters shall be steel: Dresser Style 62 or 162, Smith-Blair Series 413, Baker Series 212 or 240, or equal.

2.05 FLANGED COUPLING ADAPTERS FOR STEEL PIPE

A. Flanged coupling adapters for steel pipe shall be steel: Dresser Style 128, Smith-Blair Type 913, Baker 602, or equal. Flange ends shall match the size and dimensions of the connecting pipe flange; see detail piping specifications.

2.06 FLEXIBLE PIPE COUPLING BONDS

A. Flexible pipe coupling bonds shall be stranded copper wire with THWN insulation, brazed to the pipe and coupling as shown on the Plans. The bonding wire shall allow a total of one inch expansion or contraction of the pipe joint.

2.07 COUPLINGS FOR GROOVED AND SHOULDERED JOINTS

A. Couplings for grooved and shouldered joints shall be in accordance with AWWA C606. Couplings shall be cast of ductile iron conforming to ASTM A536 with a synthetic rubber gasket. Nuts and bolts shall be in accordance with ASTM A183.

B. Couplings for pipe 24 inches and smaller shall be flexible type, square cut groove, such as Victaulic style 77, Gustin-Bacon Figure 100, or equal. Use Victaulic Style 44, or equal, couplings with Type “D” collars for pipe 24 inches and larger.

2.08 BOLTED SPLIT TYPE SLEEVE COUPLINGS

A. Couplings shall be bolted, split-sleeve, double point closure couplings that meet or exceed the performance requirements of AWWA C-219, and shall be constructed to match the outside diameters of adjoining pipe sections as shown on the Plans. Couplings shall be constructed for the specific installation.

B. Coupling housings and closure plates shall be constructed of ASTM A-36 carbon steel, unless otherwise indicated on the Plans, and shall have a wall thickness not less than the pipe for which the coupling is to be used.

C. End rings shall be provided with the coupling and constructed of ASTM A-36 carbon steel. Ring size shall follow the manufacturer’s recommendation. The main weld and back weld for attaching the end rings to the pipe shall be welded the full circumference of the pipe and shall be sized per the Manufacturer’s recommendations.

D. Bolts, nuts, and washers shall be provided by the coupling manufacturer and shall conform to ASTM A-325, with minimum tensile strength of 120,000 psi.

E. Gaskets shall be constructed of elastomers as designated by ASTM D-2000.

F. Manufacturer shall be Victaulic Depend-O-Lok, Inc., or approved equal.

2.09 DISMANTLING JOINTS

A. Dismantling joints shall be a restrained flange by flange coupling, manufactured as a single unit that allows a minimum of two inches of longitudinal adjustment and a maximum of three degrees axial deflection. Flange ends shall match the size and dimensions of the connecting pipe flange. The internal diameter of the lined dismantling joint shall be equal to the internal diameter, including lining material, of the pipe to which the dismantling joint is attached.

B. The flange adapter and spigot shall be fabricated from steel to ASTM A283 Grade C, or steel of the same grade used to fabricate the steel pipe to which the dismantling joint is attached. The thickness of the flange
adapter and spigot shall be at least that specified for the size of pipe to which the dismantling joint is attached.

C. Bolts and tie-rods shall conform to ASTM A307, Grade B or ASTM A193 Grade B7. Provide nuts and washers of matching materials. The tie rod restraint system shall be capable of withstanding one and one-half times the design hydrostatic test pressure at not more than 50 percent of the yield strength of tie rod material. The tie rod restraint system shall not extend outside the flange diameter.

D. The gasket seal and compression stud and nut arrangement shall be independent of the tie rod restraint system.

E. The manufacturer shall have at least five years experience in manufacturing dismantling joints. Dismantling joints shall be manufactured by Viking Johnson, or equal.

PART 3 - EXECUTION

3.01 INSTALLATION OF PIPE COUPLINGS
A. Clean oil, scale, rust, and dirt from pipe ends. Clean gaskets in flexible pipe couplings before installing.

B. Install couplings per manufacturer's recommendations. Install couplings so that 50 percent of total travel is available for expansion and 50 percent is available for contraction.

C. Lubricate bolt threads with graphite and oil prior to installation.

D. Install bolted split type sleeve coupling using manufacturer’s hydraulic tool. Follow all manufacturer’s instructions including applying sufficient manufacturer lubricant to coupling after all other piping is installed or remove coupling and reinstall to ensure joint is not under stress.

3.02 PAINTING AND COATING
A. Coat buried flexible pipe couplings (including joint harness assemblies), transition couplings, and flanged coupling adapters per Section 09900, Painting and Coating, System No. 21. Coat buried bolt threads, tie bolt threads, and nuts per Section 09900, Painting and Coating, System No. 24. Then wrap the couplings with 8-mil polyethylene wrap per AWWA C105.

B. Coat flexible pipe couplings (including joint harness assemblies), transition couplings, and flanged coupling adapters located indoors, in vaults and structures, and above ground with the same coating system as specified for the adjacent pipe. Apply prime coat at factory.

C. Line flexible pipe couplings with epoxy per Section 09900, Painting and Coating, System No. 7.

D. Line and coat dismantling joints with epoxy per Section 09900, Painting and Coating, System No. 7, or Rilsan Nylon 11.

3.03 BONDING FLEXIBLE PIPE COUPLINGS
A. Bond buried flexible pipe couplings that are connected to steel pipe in accordance with Section 16640, Cathodic Protection.

3.04 HYDROSTATIC TESTING
A. Hydrostatically test the pipe with flexible pipe couplings, expansion joints, and expansion compensators in place. Test in accordance with Section 02676, Pressure Testing of Piping.

END OF SECTION
SECTION 15142 - WALL PIPES, SEEP RINGS, AND PENETRATIONS

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes materials, installation, and testing of steel and cast-iron wall pipes and sleeves (including wall collars and seepage rings), and penetrations.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03000 General Concrete Construction
B. Section 09900 Painting and Coating
C. Section 15144 Pipe Hangers and Supports

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American National Standards Institute
   B31.3 Chemical Plant and Petroleum Refinery Piping.
   B36.10 Welded and Seamless Wrought Steel Pipe.

B. American Petroleum Institute
   5L Specification for Line Pipe.

C. American Society for Testing and Materials
   A53 Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
   A105 Specification for Forgings, Carbon Steel, for Piping Components.
   A139 Specification for Electric-Fusion-Welded Steel Pipe.
   A181 Specification for Forgings, Carbon Steel, for General-Purpose Piping.
   A182 Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.

C. American Welding Society
   D1.1 Structural Welding Code Steel Twelfth Edition.

1.04 SUBMITTALS

A. Detail drawings for fabricated steel or cast-iron wall and floor pipes and sleeves, wall flanges, seep rings, and sealing materials. Show dimensions and wall thicknesses.

B. Show flange sizes and the appropriate flange dimensional standard where flanged end wall pipes or penetrations are used.
C. Show grooved-end dimensions and AWWA grooved-end dimensional standard where grooved-end wall pipes or penetrations are used.

D. List coating systems to be applied, manufacturer, and dry thickness of coatings. Call out coatings where coatings are to be applied.

E. List materials of construction, with ASTM material reference and grade.

F. Manufacturer’s instructions for installing rubber annular hydrostatic sealing devices.

G. Welder qualifications in accordance with AWS D1.1.

PART 2 - MATERIALS

2.01 GENERAL

A. Use fabricated steel wall sleeves when containing rubber annular hydrostatic sealing devices through which piping passes.

2.02 FABRICATED STEEL WALL FLANGES AND SLEEVES

A. Provide fabricated steel wall flanges and sleeves as shown on the Plans for pipes where they pass through concrete walls and slabs which are to be watertight. Wall thickness for sleeves shall be standard weight per ANSI B36.10.

B. Seep ring shall be in the form of a steel ring or collar welded to the sleeve or pipe. Cut collars from a 3/16 inch steel plate. Attach the collar to the sleeve or pipe with full circle, 1/8 inch fillet welds. Welding procedures shall be in accordance with ANSI B31.3, Chapter V.

C. Steel pipe used in fabricating wall sleeves shall comply with ASTM A53 (Type E or S), Grade B; ASTM A135, Grade B; ASTM A139, Grade B; or API 5L or 5LX. Wall sleeves connecting to steel pipe shall be of the same material as the connecting pipe. Wall sleeves shall be hot dipped galvanized. Wall collar material shall comply with ASTM A105, A181, or A182.

D. Pressure test at least one of each size of fabricated steel wall sleeve or penetration and collar assemblies at the place of fabrication to demonstrate watertightness of the seal between the collar and the sleeve. The test shall be at a pressure of 20 psig for four hours’ duration and shall show zero leakage.

2.03 RUBBER ANNULAR HYDROSTATIC SEALING DEVICES

A. Rubber annular hydrostatic sealing devices shall be of the modular mechanical type, utilizing interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe sleeve and the passing pipe. Assemble links to form a continuous rubber belt around the pipe, with a pressure plate under each bolthead and nut.

B. Materials of construction shall be as follows:

<table>
<thead>
<tr>
<th>Compound</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure plate</td>
<td>Carbon steel</td>
</tr>
<tr>
<td>Bolts and nuts for links</td>
<td>Type 303 or 316 stainless steel</td>
</tr>
<tr>
<td>Sealing element</td>
<td>EPDM rubber</td>
</tr>
</tbody>
</table>

C. The size of the wall sleeve needed to accommodate the passing pipe shall be as recommended by the rubber annular seal manufacturer.
2.04 POLYETHYLENE FOAM FILLER FOR PIPE PENETRATIONS

A. Packing foam shall be an extruded closed-cell polyethylene foam rod, such as Minicel backer rod, manufactured by Industrial Systems Department, Plastic Products Group of Hercules, Inc., Middletown, Delaware; Ethafoam, as manufactured by Dow Chemical Company, Midland, Michigan; or equal. The rod shall be 1/2 inch larger in diameter than the annular space.

PART 3 - EXECUTION

3.01 LOCATION OF PIPES AND SLEEVES

A. Provide a wall or floor pipe where shown on the Plans and wherever piping passes through walls or floors in which the groundwater surface is above the pipe penetration.

B. Provide a floor sleeve where shown on the Plans and wherever plastic pipe or steel pipe three inches and smaller or copper tubing passes through a floor or slab. Provide a rubber annular sealing device in the annular space between the sleeve and the passing pipe or tubing.

C. Provide wall sleeves where shown on the Plans and wherever plastic pipe, steel or stainless steel pipe three inches and smaller, or stainless steel or copper tubing passes through a wall. Provide a single rubber annular seal when the wall is eight inches thick or less. Provide two rubber annular seals (one at each end of the sleeve) when the wall is more than eight inches thick. Pack the annular space with polyethylene foam filler and fill the ends of the penetration with two inches of elastomeric sealant on both sides of the structure.

D. Where sleeves are installed in which water or soil is on one or both sides of the wall, provide two rubber annular seals (one at each end of the sleeve).

E. Where pipes pass through walls or slabs and no sleeves or wall or floor pipe with seep ring is provided, pack the annular space with polyethylene foam filler and fill the ends of the penetration with two inches of elastomeric sealant on both sides of the structure.

3.02 INSTALLATION IN EXISTING CONCRETE WALLS AND SLABS

A. Core drill holes two inches larger in diameter than the diameter of the wall flange or collar. Install wall pipe and collar assembly axially aligned with the piping to which it will be connected or will contain. Pack the void space between the sleeve and concrete with non-shrink grout. See Section 03000, General Concrete Construction, for grouting specification.

3.03 INSTALLATION IN NEW CONCRETE WALLS AND SLABS

A. Install wall pipes in walls before placing concrete. Do not allow any portion of the sleeve to touch any reinforcing steel. Install wall sleeve and collar assembly axially aligned with the piping to which it will be attached or will contain.

3.04 INSTALLATION OF WALL PIPES HAVING FLANGED END CONNECTIONS

A. Check alignment before grouting in place or pouring concrete. Realign if the sleeve is not properly aligned.

B. Install flanged end wall sleeves or penetrations with bolt holes of the end flanges straddling the horizontal and vertical centerlines of the sleeve.

C. Lubricate flange bolts with oil and graphite prior to installation.

D. Where a flanged pipe penetrates a wall or slab, provide a minimum distance of 15 inches from the wall or slab to face of flange.

3.05 INSTALLATION OF RUBBER ANNULAR HYDROSTATIC SEALING DEVICES

A. Install in accordance with the manufacturer's instructions.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes materials and installation of pipe hangers and supports including accessory items, such as anchor bolts and screws and neoprene isolation sleeves.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02653 Steel Pipe
B. Section 09900 Painting and Coating
C. Section 15058 PVC Pipe and Fittings, Three Inches and Smaller
D. Section 15122 Pipe Couplings and Expansion Joints
E. Section 15142 Wall Pipes, Seep Rings, and Penetrations
F. Section 15891 PVC Pipe Vent Systems

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Society of Testing and Materials
   A36 Specification for Structural Steel.
   A153 Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   A194 Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Services.
   A276 Specification for Stainless and Heat Resisting Steel Bars and Shapes.
   A446 Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural Quality.
   A527 Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality.
   A570 Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality.
   A575 Carbon, Merchant Quality, M-Grades.
   F594 Specification for Stainless Steel Nuts.
B. Manufacturers Standardization Society of the Valve and Fittings Industry
   SP-58 Pipe Hangers and Supports-Materials Design and Manufacture.
1.04 SUBMITTALS

A. Provide line drawings of each piping system to the scale shown on the Plans, locating each support and hanger. Identify each type of hanger or support by the manufacturer's catalog number or figure.

B. Provide installation drawings and manufacturer's catalog information on each type of hanger and support used.

PART 2 - MATERIALS

2.01 DESIGN CRITERIA

A. No attempt has been made to show or detail in the Plans every pipe support or hanger required. Provide pipe supports for every piping system installed.

B. Pipe support and hanger components shall withstand the dead loads imposed by the weight of the pipes filled with water and shall have a minimum safety factor of five based on material ultimate tensile strength.

2.02 HANGER AND SUPPORT SYSTEMS

A. Pipe hangers and supports shall comply with Manufacturer's Standardization Society SP-58 for the standard types referenced on the Plans. Construct special hangers and supports as detailed on the Plans. Type numbers for standard hangers and supports shall be in accordance with Manufacturer's Standardization Society SP-58 as listed below:

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Description</th>
<th>Manufacturer and Model (or equal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Adjustable steel clevis</td>
<td>Grinnell Fig. 590 or 260, Kin-Line 455, B-Line B3100 or B3102</td>
</tr>
<tr>
<td>3</td>
<td>Steel double-bolt pipe clamp</td>
<td>Kin-Line 473, Grinnell Fig295A or 295H, B-Line B3144 or B3144A</td>
</tr>
<tr>
<td>5</td>
<td>Pipe hanger</td>
<td>Kin-Line 450, B-Line B669</td>
</tr>
<tr>
<td>7</td>
<td>Adjustable steel band</td>
<td>Grinnell Fig. 269, Atlanta hanger Engineering Fig. 22</td>
</tr>
<tr>
<td>8</td>
<td>Extension pipe or riser</td>
<td>Grinnell Fig. 261, B-Line clamp B5573</td>
</tr>
<tr>
<td>9</td>
<td>Adjustable band hanger</td>
<td>Grinnell Fig. 97</td>
</tr>
<tr>
<td>10</td>
<td>Adjustable swivel ring band hanger</td>
<td>Grinnell Fig. 70 B-Line B3170 NF</td>
</tr>
<tr>
<td>13</td>
<td>Steel turnbuckle</td>
<td>Grinnell Fig. 230 B-Line B3202</td>
</tr>
<tr>
<td>14</td>
<td>Steel clevis</td>
<td>Grinnell Fig. 299 B-Line B3201</td>
</tr>
<tr>
<td>15</td>
<td>Swivel turnbuckle</td>
<td>Grinnell Fig. 114 B-Line B3224</td>
</tr>
<tr>
<td>18</td>
<td>Steel or malleable iron concrete insert</td>
<td>Grinnell Fig. 281, Superstrut 452</td>
</tr>
<tr>
<td>24</td>
<td>U-bolt</td>
<td>Grinnell Fig. 137, Kin-Line 437 B-Line B3188</td>
</tr>
<tr>
<td>26</td>
<td>Clip</td>
<td>Grinnell Fig. 262, Kin-Line 477, B-Line B3180</td>
</tr>
<tr>
<td>31</td>
<td>Light welded steel Bracket</td>
<td>Grinnell Fig. 194 B-Line B3063</td>
</tr>
<tr>
<td>32</td>
<td>Medium welded steel bracket</td>
<td>Grinnell Fig. 195 B-Line B3066</td>
</tr>
<tr>
<td>33</td>
<td>Heavy welded steel bracket</td>
<td>Grinnell Fig. 199 B-Line B3067</td>
</tr>
<tr>
<td>36</td>
<td>Pipe saddle support</td>
<td>Grinnell Fig. 258, Kin-Line 465, B-Line B3095</td>
</tr>
<tr>
<td>37</td>
<td>Pipe stanchion saddle</td>
<td>Grinnell Fig. 259, Kin-Line 467, B-Line B3090</td>
</tr>
<tr>
<td>Type No.</td>
<td>Description</td>
<td>Manufacturer and Model (or equal)</td>
</tr>
<tr>
<td>---------</td>
<td>---------------------------------</td>
<td>--------------------------------------</td>
</tr>
<tr>
<td>38</td>
<td>Adjustable pipe saddle support</td>
<td>Grinnell Fig. 264, B-Line B3093/B3089</td>
</tr>
</tbody>
</table>

B. Pipe hangers and supports shall be hot-dipped galvanized per ASTM A153 carbon steel (ASTM A36, A575, or A576). Bases, rollers, and anchors shall be steel as described above or may be cast iron (ASTM A48). Pipe clamps shall be steel as described above or may be malleable iron (ASTM A47).

C. Pipe hangers and supports shall be as manufactured by Grinnell, Kin-Line, Unistrut, B-Line, Superstrut, or equal.

2.03 OFFSET PIPE CLAMP

A. Grinnell Figure 103, or equal. Material shall be Type 316 stainless steel.

2.04 STEEL CHANNEL FRAMING SYSTEM

A. Steel channel frames shall be 1-5/8 inches wide by 1-5/8 inches or 3-1/4 inches high by 12 gauge metal thickness (for steel construction) or 14 gauge (for stainless steel construction), unless otherwise shown on the Plans. Material shall conform to ASTM A36, A446, A527, or A570 (Grade 33 minimum) unless stainless steel is indicated on the Plans. Stainless steel shall be Type 304. One side of the channel shall have a continuous open slot with inturned clamping ridges. Maximum allowable stress under any combination of applied uniformly distributed loads and concentrated loads shall not exceed those recommended in the AISC or AISI. Deflection shall not exceed 1/240 of span. Use multiple back-to-back channels to achieve these criteria if single channels are not sufficient. Products: Unistrut P1000 or P5000 Series, Kin-Line 4112 Series, or equal.

B. Steel channels shall be hot-dipped galvanized per ASTM A153.

C. Nuts shall be machined and case hardened. Provide rectangular nuts with the ends shaped to permit a quarter turn crosswise in the framing channel. Provide two serrated grooves in the nut to engage the inturned edges of the channel.

D. Pipe clamps (including attachment screws and nuts) shall be Unistrut P1100 or P2000 Series, Kin-Line 412 Series, or equal. Material shall be Type 304 stainless steel.

E. Accessory fittings and brackets shall be the same material as the channel. Provide coating on carbon steel fittings and brackets as specified for the channels and frames.

1. Flat Plate Fittings: Unistrut P1065, P1066, P1925; Superstrut AB-206, AB-207; or equal.


3. 90-Degree Brackets: Unistrut P1326, P1346; Superstrut AB-203; or equal.

4. Rounded-End Flat Plate Fittings: Unistrut P2325, Superstrut X-240, or equal.

F. Parallel pipe clamps shall be Unistrut P1563 through P1573, Superstrut AB-719, or equal. Material shall be carbon steel, coated as specified for channels and frames.

2.05 ANCHOR BOLTS AND SCREWS

A. Anchor bolts and screws for attaching pipe supports and hangers to walls, floors, ceilings, and roof beams shall be stainless-steel per ASTM A193, Grade B8M, Class 2. Nuts shall be ASTM A194, Grade 8M, or ASTM F594, Type 316, Condition SH. Provide a washer under each nut and under each bolthead. Washers shall be of the same material as the nuts.
2.06 NEOPRENE ISOLATING SLEEVES FOR METAL PIPE TWO INCHES AND SMALLER

A. Neoprene isolating sleeves shall be Unistrut P2600, Kin-Line 418 and 419, or equal.

PART 3 - EXECUTION

3.01 PIPE HANGER AND WALL SUPPORT SPACING

A. Install pipe hangers and wall supports on horizontal and vertical runs at the spacing shown or detailed on the Plans. Provide hanger rods (for horizontal runs) and wall supports of the sizes shown or detailed on the Plans. If no spacing or rod sizes are given in the Plans or in the specifications for a particular piping system, use the following:

1. Pipe Hanger and Wall Support Spacing for Steel Pipe (Section 02653, Steel Pipe):

<table>
<thead>
<tr>
<th>Pipe Size (inches)</th>
<th>Maximum Support or Hanger Spacing (feet)</th>
<th>Minimum Rod Size (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8 and smaller</td>
<td>4</td>
<td>3/8</td>
</tr>
<tr>
<td>1/2 through 1</td>
<td>6</td>
<td>3/8</td>
</tr>
<tr>
<td>1-1/4 through 2</td>
<td>8</td>
<td>3/8</td>
</tr>
<tr>
<td>2-1/2 and 3</td>
<td>10</td>
<td>1/2</td>
</tr>
<tr>
<td>3-1/2 and 4</td>
<td>10</td>
<td>5/8</td>
</tr>
<tr>
<td>6</td>
<td>12</td>
<td>3/4</td>
</tr>
<tr>
<td>8</td>
<td>12</td>
<td>7/8</td>
</tr>
<tr>
<td>10 and 12</td>
<td>14</td>
<td>7/8</td>
</tr>
<tr>
<td>14 and 16</td>
<td>16</td>
<td>1</td>
</tr>
<tr>
<td>18</td>
<td>15</td>
<td>1</td>
</tr>
<tr>
<td>20 through 24</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>30</td>
<td>6</td>
<td>1</td>
</tr>
</tbody>
</table>

2. Pipe Hanger or Wall Support Spacing for PVC Pipe (Section 15058, PVC Pipe and Fittings, Three Inches and Smaller):

<table>
<thead>
<tr>
<th>Pipe Size (inches)</th>
<th>Maximum Support or Hanger Spacing (feet)</th>
<th>Minimum Rod Size (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4</td>
<td>4</td>
<td>3/8</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>3/8</td>
</tr>
<tr>
<td>1-1/2</td>
<td>5</td>
<td>3/8</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>3/8</td>
</tr>
<tr>
<td>2-1/2</td>
<td>5</td>
<td>1/2</td>
</tr>
<tr>
<td>3 through 6</td>
<td>6</td>
<td>1/2</td>
</tr>
</tbody>
</table>

3. Provide sway bracing for hangers where detailed on the Plans. If no bracing is detailed, provide bracing at ten-foot maximum center-to-center intervals.
3.02 PIPE SUPPORT SPACING FOR SUPPORTS ON TOP OF SLABS OR GRADE

A. Install pipe supports on horizontal runs at the spacing shown on the Plans. If no spacings are shown, use the following:

1. Pipe Support Spacing:

<table>
<thead>
<tr>
<th>Pipe Size (inches)</th>
<th>Maximum Support Spacing (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8 and smaller</td>
<td>4</td>
</tr>
<tr>
<td>1/2 through 1</td>
<td>6</td>
</tr>
<tr>
<td>1-1/4 through 2</td>
<td>8</td>
</tr>
<tr>
<td>2-1/2 and 3</td>
<td>10</td>
</tr>
<tr>
<td>3-1/2 and 4</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>10 and 12</td>
<td>14</td>
</tr>
<tr>
<td>14 and 16</td>
<td>16</td>
</tr>
<tr>
<td>18</td>
<td>16</td>
</tr>
<tr>
<td>20 through 24</td>
<td>18</td>
</tr>
<tr>
<td>30</td>
<td>18</td>
</tr>
</tbody>
</table>

3.03 INSTALLING PIPE HANGERS AND SUPPORTS

A. Provide separate hangers and supports at valves. Provide one hanger or support around each end of the valve body or on the adjacent connecting pipe within one pipe diameter of the valve end.

B. Provide separate hangers and supports at each pipe elbow, tee, or fitting. Provide separate hangers and supports on both sides of each nonrigid joint or flexible pipe coupling.

C. Install piping without springing, forcing, or stressing the pipe or any connecting valves, pumps, and other equipment to which the pipe is connected.

D. Use 1-5/8 inch high channel frames unless 3-1/4 inch is needed to provide clearance from walls. Use multiple back-to-back channels if additional clearance is needed.

E. Provide temporary support for valves and equipment until permanent supports are installed. Do not hang valves and equipment off of piping.

3.04 INSTALLING NEOPRENE ISOLATING SLEEVES

A. Install a neoprene isolating sleeve around each metal pipe two inches and smaller at the point of bearing or contact with the pipe hanger or support.

3.05 PAINTING AND COATING

A. Paint exposed nongalvanized pipe hangers and supports to match the color of the adjacent wall using System No. 10 or System No. 11 per Section 09900, Painting and Coating. Coat galvanized pipe supports per Section 09900, Painting and Coating, System No. 52. Color of finish coat shall match adjacent piping. If the adjacent wall is not painted, paint the hangers and supports to match color code of the largest pipe on the support.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes materials and installation of markers, labels, and signs for pipes, ducts, and valves, for mechanical equipment, and for miscellaneous plant services.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 15100 Valves

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American National Institute

A13.1 Scheme for the Identification of Piping Systems.

Z53.1 Safety Color Code for Marking Physical Hazards.

1.04 SUBMITTALS

A. Manufacturer's catalog data and descriptive literature describing materials, colors, letter size, and size of labels.

PART 2 - MATERIALS

2.01 LABELS FOR PIPING

A. Labels for piping shall bear the full piping system name as shown in the Plans. Provide separate flow directional arrows next to each label. Color, size, and labeling shall conform to ANSI A13.1 and Z53.1. Labels for piping inside buildings shall be vinyl cloth: W. H. Brady Co. B-500 vinyl cloth, Seton Name Plate Corporation Pipe Markers, or equal. Labels for piping located outdoors shall be weather- and ultraviolet-resistant acrylic plastic and shall be W. H. Brady Co. B-946, Seton Name Plate Corporation Pipe Markers, or equal.

B. Alternatively, provide preprinted, semirigid, snap-on, color-coded pipe markers. Color, size, and labeling shall conform to ANSI A13.1 and Z53.1. Label shall cover 360 degrees (minimum). Labels shall be fabricated of weather- and ultraviolet-resistant acrylic plastic. Labels shall be Seton Nameplate Corporation SetMark pipe marks or equal.

C. Furnish one inch thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 degrees F or greater. Cut length to extend two inches beyond each end of plastic pipe marker.

2.02 LABELS FOR VALVES

A. Provide each valve of size larger than two inches with an identification tag. Tag shall be two inch square or circular aluminum or 1/16 inch thick fiberglass: W. H. Brady B-60, Seton Name Plate Corp. Series SVT, or equal. Aluminum tags shall have black-filled letters. Tag shall show the pipeline station where valve is to be installed, type, manufacturer, date of manufacturer, and pressure rating.

2.03 HOSE BIB SIGNS-UNSAFE WATER

A. Provide a rigid sign labeled "DANGER-UNSAFE WATER" for each hose bibb. Size and lettering shall conform to CALOSHA requirements. Signs shall be Seton Nameplate Company 20-gauge baked enamel, minimum size seven inches by three inches; Brady B-120 Fiber-Shield fiberglass, minimum size seven inches by three inches, 1/8 inch thick; or equal.
2.04 LABELS FOR MECHANICAL EQUIPMENT
   A. Provide a label for each piece of mechanical equipment. Label shall contain the equipment name and tag number as shown in the Plans. Lettering shall conform to CALOSHA requirements. Labels shall be 1-1/2 inches (minimum) by four inches (minimum) brass, aluminum, or 1/8 inch thick fiberglass tags: Brady B-120 Fiber-Shield, Seton Style 2065, or equal.

2.05 LABELS FOR TANKS
   A. Signs shall be weather- and ultraviolet-resistant. Lettering shall conform to CALOSHA requirements. Labels shall be Brady B-946, Seton Name Plate Corporation PSPL, or equal. Minimum size shall be seven inches by ten inches. Provide a sign on each tank bearing the tank tag number and the name of the liquid stored.

2.06 WALL SIGNS
   A. Wall signs shall be 1-1/2 inches by four inches (minimum dimensions), 1/16-inch thick satin-surfaced material conforming to MIL-P-78A or MIL-P-150240. Lettering shall be 1/2-inch high white letters on black background. Do not provide mounting holes.

2.07 LABELS FOR AUTOMATIC START/STOP EQUIPMENT
   A. Provide a sign reading "CAUTION-EQUIPMENT STARTS AND STOPS AUTOMATICALLY" on pieces of equipment as shown on the Plans. Signs shall be pressure sensitive vinyl with adhesive for application to equipment. Size shall be ten inches by seven inches minimum. Products: Seton, Brady, or equal.

PART 3 - EXECUTION

3.01 INSTALLING PIPE LABELS
   A. Provide label and flow arrow at each connection to pumps or other mechanical equipment, at wall boundaries, at tees, and crosses.
   B. For external diameters less than six inches (including insulation, if any), provide full-band pipe markers, extending 360 degrees around pipe at each location.
   C. For external diameters of six inches and larger (including insulation, if any), provide either full-band or strip-type pipe markers but not narrower than three times letter height (and of required length), fastened by one of the following methods:
      1. Laminated or bonded application of pipe marker to pipe or insulation.
      2. Strapped-to-pipe or insulation application of semirigid type with Type 304 or 305 stainless steel bands.

3.02 INSTALLING VALVE AND EQUIPMENT LABELS
   A. Attach labels to the valve body or piece of equipment with a pop rivet or equal.
   B. Attach valve labels to the valve handwheels. If the valve has no handwheel, attach the label to the valve by tying the tag wire or chain around the operating shaft or nut.

3.03 INSTALLING SIGNS
   A. Attach per sign manufacturer's recommendations and CALOSHA requirements. Attach signs to walls using epoxy adhesive.

3.04 INSTALLING LABELS FOR AUTOMATIC START/STOP EQUIPMENT
   A. Attach signs for exposed equipment directly to the equipment.
   B. Attach signs for sump pumps on the adjacent wall.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes materials, installation, and testing of polyvinyl chloride pipe and fittings of sizes six inches through ten inches for use in ventilation having a maximum operating pressure of four inch W.C., vacuum of four inch W.C., and maximum operating temperature of 150 degrees F.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02200 Earthwork
B. Section 03000 General Concrete Construction
C. Section 15144 Pipe Hangers and Supports

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Society for Testing and Materials
   D1785 Specification for Poly Plastic Pipe.
   D2774 Recommended Practice for Underground Installation of Thermoplastic Pressure Piping.
   D2855 Practice for Making Solvent-Cemented Joints with Poly Pipe and Fittings.

1.04 SUBMITTALS

A. Submit materials list of pipe, fittings, and solvent cement.

PART 2 - MATERIALS

2.01 PIPE MATERIALS

A. Pipe. Pipe shall be Schedule 40, Type 1, conforming to ASTM D1784 and D1785.
B. Fittings. Fittings shall be Schedule 40 and shall conform to ASTM D1784 and D2466 for socket-type fittings.
C. Flanges. PVC flanges shall be made of the same material as the ventilation pipe and have socket-type fittings.
D. Coupling Adapter. The fitting necessary to connect PVC to same size steel pipe shall be a split cast-iron housing with neoprene gasket and a minimum of four stainless steel bolts and nuts. The coupling shall be MG Piping Products Company, MG coupling or equal.
2.02 JOINTS

A. Pipe and fitting joints shall be socket welded except where flanged joints are required to connect to equipment.

B. Solvent cement for socket joints shall comply with ASTM D2564.

C. Gaskets for flanged joints shall be full-faced, 1/8 inch thick neoprene. When the mating flange has a raised face, provide a flat ring gasket filler between the PVC flange gasket and the adjacent flange.

PART 3 - EXECUTION

3.01 GENERAL

A. Do not install PVC pipe when the ambient temperature is below 40 degrees F or above 90 degrees F. Provide shade from direct sunlight for pipe stored outdoors until pipe is covered.

B. Store fittings indoors in their original cartons.

C. Store solvent cement indoors or, if outdoors, shade from direct sunlight exposure. Do not use solvent cements which have exceeded the shelf life marked on the storage containers.

D. Before installation, check pipe and fittings for cuts, scratches, gouges, buckling, kinking, or splitting on pipe ends. Do not drag PVC pipe over the ground, drop it onto the ground, or drop objects on it. Remove any pipe section containing defects by cutting out the damaged section as a complete cylinder.

E. Cut pipe ends square and remove all burrs, chips, and filings before joining pipe or fittings. Bevel solvent welded pipe ends as recommended by the pipe manufacturer.

3.02 SOLVENT WELDED JOINTS

A. Prior to solvent welding, remove fittings and couplings from their cartons and expose them to the air at the same temperature conditions as the pipe for at least one hour.

B. Wipe away loose dirt and moisture from the inside and outside of the pipe end and the fitting before applying solvent cement. Do not apply solvent cement to wet surfaces.

C. Make up solvent welded joints per ASTM D2855.

D. Allow at least eight hours of drying time before moving solvent welded joints or subjecting the joints to any internal or external loads.

3.03 FLANGED JOINTS

A. Lubricate bolt threads with TRX-Synlube by Ramco, Anti-Seize by Ramco, or equal before installation.

B. Tighten bolts on PVC flanges by tightening the nuts diametrically opposite each other using a torque wrench. Complete tightening shall be accomplished in stages and the final torque values shall be 20 to 30 foot pounds.

3.04 INSTALLING BURIED PIPE

A. After the pipe has been solvent welded and the joints have set, install the pipe in the trench per the pipe manufacturer's recommendations in order to allow for thermal expansion and contraction of the pipe.

B. Do not backfill the pipe trench until the solvent welded joints have set. Support the pipe uniformly and continuously over its entire length on firm, stable soil. Do not use blocking to change pipe grade or to support pipe in the trench.
C. Install buried PVC pipe in accordance with ASTM D2774 and the pipe manufacturer's recommendations. Backfill materials in the zone between the trench bottom and to a point eight inches above the top of the pipe shall be imported sand per Section 02200, Earthwork. Compact by means of vibratory equipment or by flooding. Apply backfill in layers having a maximum thickness of eight inches. If water flooding is used, do not add successive layers unless the previous layer is compacted to 90 percent relative compaction.

D. Where shown on the Plans, encase PVC pipe in Class A concrete per Section 03000, General Concrete Construction.

3.05 INSTALLING ABOVE-GROUND PIPE

A. Install pipe on pipe hangers and supports as detailed on the Plans and as specified in Section 15144, Pipe Hangers and Supports. Install pipe without springing, forcing, or stressing the pipe or the adjacent valves, equipment or fittings to which the pipe is connected.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes the furnishing, installing, and testing of electric power, lighting, grounding, control, and other systems, including equipment and devices. Perform work as specified to provide complete operational and functional electrical systems. All electrical work shall comply with all applicable safety regulations including but is not limited to OSHA and CalOSHA regulations and safety orders.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 16110 Raceways and Fittings
B. Section 16120 Wires and Cables
C. Section 16140 Wiring Devices
D. Section 16160 Cabinets and Consoles
E. Section 16161 Safety Socket Can
F. Section 16450 Grounding
G. Section 16460 General Purpose Dry Type Transformers
H. Section 16470 Panelboards
I. Section 16500 Lighting Systems
J. Section 16720 Intrusion Alarm System
K. Section 16721 Fire Alarm System
L. Section 16900 Electrical Controls and Misc. Electrical Equipment
M. Section 16940 General Instrumentation System Requirements
N. Section 16941 Field Mounted Instruments
O. Section 16946 Uninterruptible Power Supply

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Occupational Safety and Health Administration
   OSHA Part 1910; Subpart S, 1910.308.
   OSHA Part 1926; Subpart v, 1926.950 through 1926.960.
B. California Occupational Safety and Health Administration
   CalOSHA – California Code of Regulations, Title 8, Subchapter 5, Electrical Safety Orders.
C. National Fire Protection Association

70 National Electrical Code.
70B Electrical Equipment Maintenance.
70E Electrical Safety Requirements for Employer Workplaces.
78 Lightning Protection Code.

D. American National Standards Institute

Z244-1 Personnel Protection.

1.04 UTILITY COMPANY COORDINATION

A. The Water Authority shall make application for permanent electrical service with San Diego Gas and Electric Company and permanent voice and data telephone service with SBC, where required, in the Water Authority's name, and pay for all connection costs and application fees.

B. The Contractor shall pay all utility bills prior to acceptance of the work. The Water Authority shall pay for all utility bills after acceptance of the work.

C. The Contractor shall abide by all conditions and requirements contained within the utility companies installation and service agreements, and shall perform all such work in accordance with utility company guidelines contained therein.

1.05 SUBMITTALS

A. Shop drawings, product data, and descriptive literature for all materials, equipment, apparatus, and other items as specified. Include the manufacturer's name, product designation, and catalog numbers. Mark all shop drawings and data submitted so that drawings and manuals clearly indicate the items applicable to the work to be performed.

B. Complete one-line diagrams, schematic diagrams, wiring diagrams, control sequence diagrams, relay diagrams, and metering diagrams showing all local and remote devices associated with each installation.

C. Complete operations and maintenance manuals for all equipment furnished under this section. Include all required cuts, drawings, equipment lists, descriptions, troubleshooting lists, complete spare parts lists and complete schematic drawings.

D. A list of all nameplates and identification tags to be installed on all devices and equipment including starters, relays, conductors, push buttons, indicating lights, and switches.

E. Samples of materials or manufacturer's specifications, if requested by the Engineer.

F. Interconnection wiring diagrams and tables.

G. Redesign work, including redesign plans and details, for additional electrical or mechanical work that is required because of the Contractor's use of an alternate item, arrangement or equipment layout other than
specified herein. All costs for the redesign work, including all additional electrical and mechanical work, shall be the responsibility of the Contractor. Redesigned or altered drawings, reviewed by the Engineer, do not relieve the Contractor of the responsibility for proper and complete installation and operation of all materials and equipment, including related accessories.

H. Proposed testing and check out forms. Provide procedures with specific instructions for the checking and testing of each electrical component of each system. Include job safety rules in test procedures.

I. List of qualified personnel for testing and checkout documenting requirements.

J. Test results for building ground loop, major equipment grounds, ground rod, motor, wire, and cable ground and continuity in accordance with the testing requirements of this section.

1.06 QUALIFICATIONS

A. All materials and equipment shall be installed in accordance with printed recommendations of the Manufacturer, which have been reviewed by the Engineer. The installation shall be accomplished by workmen skilled in this type of work, and installation shall be coordinated in the field with other trades so that interferences are avoided.

B. All work, including installation, connection, calibration, testing, adjustment, and paint touch-up, shall be accomplished by qualified, experienced personnel working under continuous, competent supervision. The completed installation shall display competent work, reflecting adherence to prevailing industrial standards and methods.

C. Furnish adequate means for and fully protect all finished parts of the materials and equipment against damage from any cause during the progress of the work and until accepted by the Engineer. All materials and equipment, both in storage and during construction, shall be covered in such a manner that no finished surfaces will be damaged, marred, or splattered with water, foam, plaster, or paint. All moving parts shall be kept clean and dry.

D. Replace or have refinished by the manufacturer, all damaged materials or equipment, including face plates of panels and switchboard sections, at no additional cost to the Water Authority.

E. Testing and checkout work is to be performed by qualified personnel skilled in the particular tests being conducted. Personnel are to have at least five years of experience with tests of the same type and size as specified. Submit qualifications for all individuals that will perform testing to the Engineer at least 30 days prior to testing. Qualification statements shall clearly identify the individuals’ qualifications, and the specific tests that each individual is qualified to perform.

F. Perform all tests required by the Water Authority or other authorities having jurisdictions. All such tests shall be performed in the presence of the Engineer. Furnish all necessary testing equipment and pay all costs of tests, including all replacement parts and labor necessary due to damage resulting from damaged equipment or from test and correction of faulty installation.

G. Standard test reports for mass-produced equipment shall be submitted along with the Shop Drawing for such equipment. Test reports on testing specifically required for individual pieces of equipment shall be submitted for review prior to final acceptance of the project.

H. Any test failure shall be corrected in accordance with the industry practices and in a manner satisfactory to the Engineer.
PART 2 - MATERIALS

2.01 GENERAL

A. The furnished electrical system shall be complete and functional. Furnish all material that is incidental to the work of this section.

B. Furnish UL listed and labeled devices and materials. Where UL listing is not available for equipment, submit test reports of an independent testing laboratory, approved by the Engineer, indicating that the equipment is in conformance with NEC, state, and local code requirements.

C. Furnish equipment, devices and material marked with name or trademark of the manufacturer and rating in volts, amperes, and other pertinent electrical information on a nameplate.

D. Furnish only products which are new, undamaged, and in the original cartons or containers.

E. Protect electrical equipment at all times against mechanical and moisture damage. Electrical equipment shall not be stored outside. Store electrical equipment in dry areas. Replace any apparatus that has been moisture damaged.

F. The following systems and equipment are typical, but not inclusive, for materials furnished in accordance with this section:

1. 120/208 volt, 3 phase, 4 wire, or 120/240 volt single phase 3 wire service entrance.

2. Lighting/Power panelboard.

3. Emergency lighting system.

4. Telephone service entrance conduit.

5. Control and alarm cabinets.

6. Raceways and fittings.

7. Wires and cables.

8. Lighting systems.


10. Grounding systems.

11. Telephone raceways.

12. Intrusion alarm system.

13. Instrumentation system.

14. Rolling steel door power and control system.

15. Bridge crane power system.

16. Motor operated in-line valve power and control system.
17. Ventilation power and control system.

18. Temporary electricity, lighting, and telephone as required during construction operations.

19. Conduit, wire, and control equipment as required for all motors and equipment.

PART 3 - EXECUTION

3.01 SAFETY PRECAUTIONS

A. Provide and maintain all safeguards necessary for the prevention of accidents and the safety of personnel. Comply with CalOSHA requirements specified in the California Code of Regulations, Title 8, Subchapter 5, Electrical Safety Orders.

B. Replace covers of energized lighting and power panelboards, removed for work purposes, when left unattended.

C. Conduct testing and checkout work in a safe manner. Provide the following safety precautions wherever they would result in a safer workplace:
   1. Lockout/Tagout procedures.
   2. Barricades.
   3. De-energizing and/or isolation of equipment prior to testing.
   4. Review of procedures with the Engineer.
   5. Erection of warning signs.
   7. Maintenance of voice communications.

3.02 INSTALLATION

A. The Plans indicate connections for typical equipment only. If the equipment furnished is different from what is shown, provide the modifications necessary for a safe and properly operating installation in accordance with the NEC requirements, and the equipment manufacturer's recommendations.

B. The Plans diagrammatically indicate the desired location and arrangement of outlets, conduit runs, equipment, and other items. Field determine exact location based on physical size and arrangement of equipment, finished elevations, and obstructions, and submit such location for approval by the Engineer prior to installation.

C. All conduit and equipment shall be installed in such a manner as to avoid all obstructions and to preserve headroom and keep openings and passageways clear. Where equipment is installed without instruction and must be moved, it shall be moved without additional cost to the Water Authority.

D. Accomplish all work and furnish and install all equipment not indicated or specified which is necessary for the intended complete operation of the electrical system.
3.03 SUPERVISION AND COORDINATION

A. Provide supervision on the site at all times to lay out, check, coordinate, and supervise the installation of all electrical work. Plan the installation of all electrical work, giving consideration to the work of other trades to prevent interference.

3.04 SCAFFOLDING, RIGGING, AND HOISTING

A. Provide all scaffolding, rigging, hoisting, and erection equipment necessary for electrical installations. Remove the same from the premises when no longer required.

3.05 SLEEVES AND FORMS FOR OPENINGS

A. Provide and place all sleeves for conduits penetrating floors, walls, and partitions. Locate all necessary slots for electrical work and form before concrete is poured.

B. Seal all openings, sleeves, penetration, and slots as specified in the Section 16110, Raceways and Fittings.

3.06 INTERPRETATION OF DRAWINGS

A. Determine conduit routing that conforms to the installation requirements set forth herein.

B. Install conduit as shown on the Plans. Conduit stubs may be exposed unless otherwise specified or indicated on the Plans.

C. Install each three-phase circuit run in a separate conduit.

D. Where circuits are indicated as "home-runs," provide all necessary fittings and boxes for a complete raceway installation.

E. Verify with the Engineer the exact locations and mounting heights of lighting fixtures, switches and receptacles prior to installation.

F. Support surface mounted panel boxes, junction boxes, and conduit with galvanized unistrut to provide a 7/8 inch clearance between walls and equipment. Securely mount unistrut with stainless steel anchors.

G. Make connections to equipment as required and in accordance with approved shop drawings.

3.07 SHIPPING AND ASSEMBLY

A. Ensure that all equipment will pass through building openings in order to reach its final location. All equipment shall be shipped and handled, and assembled, if necessary, at the job site in accordance with the manufacturer's requirements to maintain functional integrity.

3.08 COMPONENT INTERCONNECTIONS

A. Analyze all system components, identify terminals, and prepare drawings or wiring tables necessary for component interconnection.

B. Furnish and install all component interconnections.

3.09 FINAL RECORD DRAWINGS

A. Provide accurate records of the installation as work is carried out, including size, number, location and depth of all conduits, pipe ducts, and cables installed therein, and of connections to machines, equipment,
terminal boxes and switchboards, including internal connection. Provide accurate records of the internal connections and functions of the equipment installed. Record drawings shall include, but not be limited to, the following:

1. All amendments and additions to the location of outlets and equipment and routes of conduits and cables.

2. Amended drawings of detail circuit diagrams and cabling diagrams, indicating conductor sizes, conduit numbers and terminal numbers.


4. Schedules for panelboards relating fuse or circuit breaker numbers to circuit function and rating.

5. Schedules for terminal boxes and terminal strips relating terminal numbers to incoming and outgoing wires and general function (power or control).

B. Where underground electric facilities are installed, measure, record, and submit as-built dimensions.

3.10 TESTING

A. Provide supervision, labor materials, tools, test instruments, and all other equipment or services required to test, adjust, set, calibrate, and operationally check work and components of the various electrical systems and circuitry.

B. Tests are to provide initial equipment/system acceptance, provide recorded data for future maintenance and trouble shooting, and provide assurance that each system component is installed satisfactorily and can be expected to perform, and continue to perform its function with reasonable reliability.

C. Pay for all tests specified including expenses incident to retesting occasioned by defects and failures of equipment to meet specification.

D. Prior to testing and start-up, permanently identify all equipment with nameplates. Check and tighten terminals and connection points, remove shipping blocks, thoroughly clean equipment, repair damaged or scratched finishes, inspect for broken and missing parts, and review and collect manufacturer's drawings and instructions for delivery to the Engineer. Make routine checks and tests as the job progresses to ensure that wiring and equipment is properly installed.

E. Do not void equipment warranties or guarantees by testing. Checks and tests shall be supplemental to and compatible with the manufacturer's installation instruction. Where deviations are warranted, obtain the manufacturer's written approval prior to testing. Where any repairs, modifications, adjustments, or tests are to be made, the Contractor shall notify the Engineer and make such repairs, modifications, adjustments and tests in accordance with the manufacturer's recommendations.

F. Report to the Engineer any electrical equipment or system determined to be damaged, or faulty. Obtain approval from the Engineer for any corrective action and retesting. Replace wiring and equipment found defective.

3.11 TEST EQUIPMENT

A. Perform calibration and setting checks with calibrated test instruments of at least twice that of the accuracy of the equipment, device, relay or meter under test. Dated calibration labels shall be visible on test equipment. Calibrations over six months old are not acceptable on field test instruments. Inspect test instruments for proper operation prior to testing. Record the serial and model numbers of the instruments used on the test forms.
3.12 TEST PROCEDURES

A. Schedule tests and inspections as the job progresses. Conduct tests in presence of the Engineer. Notify the Engineer seven days in advance of any test scheduled to be performed.

B. After each electrical system installation is complete, perform the tests to determine that the entire system is in proper working order and in accordance with applicable codes, manufacturer's instructions, drawings, and specifications. Perform insulation and ground resistance tests before operating tests.

C. Perform insulation tests on electrical equipment at the following times and conditions:
   
   1. When equipment is delivered to the site.
   
   2. Prior to energization and/or placing into service.
   
   3. When damage to the insulation is suspected.
   
   4. After repairs or modifications to the equipment affecting the insulation.
   
   5. When it is necessary to determine or evaluate the condition of equipment insulation, especially in high ambient moisture conditions, and to determine the need for drying, cleaning, or other maintenance work or protection of such equipment.
   
   6. Where lightning or other surge conditions are known to have existed on the circuit.

D. Do not make connections at service entrance, transformers, or motors permanent until correct phase rotation of equipment is determined. Install and insulate these connections temporarily while determining proper rotation. Make permanent connections after rotation has been established and subsequent to completion of component insulation resistance and dielectric tests.

E. Make openings in circuits for test instruments and place and connect instruments, equipment, and devices, required for the tests. Upon completion of tests, remove instruments and instrument connections and restore circuits to permanent condition.

3.13 SPECIFIC TESTS

A. Motors


   2. Test motor insulation phase to ground with a meg-ohmmeter at the lowest voltage closest to operating voltage and record results. Do not exceed manufacturers maximum voltage rating for any electrical insulation.

   3. Test motor insulation winding to winding with an ohmmeter or micro-ohmmeter and record results. Do not exceed manufacturers maximum voltage rating for any electrical insulation.

   4. Test run motors uncoupled or unloaded before placing into operation. Check the motor for rotation, speed, current, and temperature rise under normal load and record the results. Maintain the proper color codes for phase identifications. This may require lead swaps at the motor for proper rotation. Use motor phase rotation meter prior to lead connection at the motor in order to minimize alter swaps.
B. Grounding Systems

1. Test building loops and major equipment grounds to earth, directly referenced to an extremely low resistance (less than one ohm) reference ground bench mark located a minimum of 20 feet from the ground test point. Perform a visual inspection of the systems, raceway and equipment grounds to determine the adequacy and integrity of the grounding. Ground testing results shall be recorded and witnessed.

2. Perform ground tests using a J.B. Biddle Company low resistance, null balance type, ground testing ohm meter, with test lead resistance compensated for. Use the type of test instrument that compensates for potential and current rod resistances.

3. Test each ground rod and measure ground resistance. If resistance is two ohms or more, drive longer rods in combination with Bentonite or other “salting” material acceptable to the Engineer to obtain a maximum resistance of two ohms.

4. Test each building and major equipment grounding system for continuity of connections and for resistance. Ground resistance of conduits, equipment cases, and supporting frames, shall not vary from that of the system as a whole and shall not exceed two ohms to ground.

C. Power Transformers

1. At the time of equipment receipt, inspect the exterior for damage or defects. Repair any damage and retest, using original factory test procedures and parts.

D. Wire and Cable

1. Before energizing any cable or wire, measure the insulation resistance of every external circuit wire to each other and to ground using a meg-ohmmeter. Conduct tests at voltages of 500 volts or lower. Test each wire and cable per continuity to verify the field applied tag on each conductor. Do not exceed manufacturers maximum voltage rating for any electrical insulation.

2. Take insulation resistance measurements for motor feeders. With motors disconnected, measure insulation resistance from the load side of conductors or circuit breakers.

3. Check cables and wires for proper identification numbering and/or color coding.

E. Relay Panels, Operator and Instrument Control Panels, Communications Systems, and other Miscellaneous Equipment

1. Upon completion of equipment installation, functionally test equipment and their control devices for tightness of connections and for proper operation. In the case of battery systems, static inverters and similar equipment, follow the manufacturer's recommended test and installation manuals. In the case of operator, instrument, and relay panels and cabinets or devices used solely for control, functionally test each circuit in the panel or cabinet for proper operation and compliance with the Plans. Where functional testing is deemed undesirable by the Engineer from a safety or plant operational standpoint, then continuity and terminal connection verification checks will be acceptable.

END OF SECTION
SECTION 16110 - RACEWAYS AND FITTINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes the furnishing and installing of complete raceway systems used to contain conductors for electrical power, communications, control circuits, and feeders.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03000 General Concrete Construction
B. Section 16050 General Electrical Requirements

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Society for Testing and Materials
   D1785 Specification for Poly Plastic Pipe.

1.04 SUBMITTALS

A. Catalog cuts showing dimensions, materials and construction details of conduits and fittings specified under this section and as shown on the Plans.

B. Complete list of all raceways to be installed under this Contract, including raceway number, size, type, source, destination and cable contained. Include wire-fill calculations and all conduits de-rating factors applied, for all raceways and conduits. Provide this information in tabular form, referenced to the final conduit or raceway number, for all conduits or raceways installed under this contract.

C. One complete set of raceway drawings showing the physical routing of all raceways furnished under this contract. The raceway drawings shall conform to the Water Authority’s drafting standards.

PART 2 - MATERIALS

2.01 RIGID STEEL CONDUIT

A. Provide heavy wall, hot-dipped galvanized, rigid steel conduit, including elbows and other factory bends.

2.02 PVC-COATED RIGID STEEL CONDUIT

A. Provide PVC-coated rigid steel conduit with an exterior coating that consists of hot-dip galvanized surfaces coated with an epoxy-acrylic primer to ensure a bond between the steel exterior substrate and the coating before the PVC coating is applied. The bond on conduit and fittings shall be greater than the tensile strength of the PVC coating. The outer PVC coating shall have a minimum thickness of 40-mils.

B. Apply two-part, red, urethane chemically cured lining to the interior of all conduit and fittings. The lining shall be applied at a nominal two-mils thickness. The urethane lining shall afford sufficient flexibility so as to permit field bending without cracking or flaking of the interior coating.

C. Include a PVC sleeve extending one conduit diameter or two inches beyond every female opening, whichever is less. The inside diameter of the sleeve shall be the same as the outside diameter of the conduit before coating. The wall thickness of the sleeve shall be at least 40 mils.

D. Repair all damaged coatings according to the manufacturer's instructions.
E. Provide PVC-coated rigid steel conduit as manufactured by Ocal, Perma-Cote, Robroy Industries, or equal.

2.03 RIGID PVC CONDUIT
A. Provide heavy wall, rigid Poly Vinyl Chloride, schedule 40, conduit, conforming to ASTM D1785.
B. Provide UL labeled rigid PVC conduit for above ground and underground uses.

2.04 LIQUIDTIGHT, FLEXIBLE METAL CONDUIT, COUPLINGS AND FITTINGS
A. Provide square-locked, liquid tight, flexible metal conduit or interlocked galvanized steel flexible conduit, covered with moisture-proof and flame-resistant polyvinyl chloride jacket, all UL labeled.
B. Provide screw-in type fittings when used with liquid tight flexible metal conduit.

2.05 CONDUIT MOUNTING EQUIPMENT
A. Provide hot-dipped galvanized iron or stainless steel channels, brackets, hangers, rods, backplates, and beam clamps as manufactured by the Appleton Electric Co., Thomas and Betts Co., Unistrut Corp., Kindorf Div. of Midland-Ross, or equal. Support equipment used to mount PVC coated rigid steel conduit shall be PVC coated.
B. Provide stainless steel anchors for mounting all conduit or strut to walls, floors, or ceilings.

2.06 WARNING TAPES
A. Warning tapes shall be three-inch minimum width yellow plastic tape. Utilize tape made of material resistant to corrosive soil. Tape shall be printed with warning that an electric circuit is located below the tape. Warning tapes shall be ITT Blackburn Type YT, Terra-Tape, or equal.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION
A. Cap conduit during construction to keep the conduit dry, clean and clear of obstructions.
B. Ream and taper thread termination and connections of rigid steel conduit. Terminate all sizes with conduit bushings. Terminate exposed conduit stubs for future use with galvanized pipe caps.
C. Install stubouts a maximum of four inches, and a minimum of two inches from the emerging surface. Space rigid steel conduit stubouts at least six inches apart, unless otherwise directed by the Plans. Terminate concealed conduit for future use in equipment or stub out from the structural surface.
D. Provide concealed portions of conduits for future equipment where the Plans indicate future duplication of equipment.
E. Terminate conduits that enter enclosures with fittings that ensure the NEMA rating of the enclosure is not changed.
F. Isolate telephone or fiber-optic cables, raceways, conduits, boxes, manholes and handholds from those of other circuits.
G. Isolate communication and instrument cables from all power wiring raceways, conduits, boxes, manholes and handholds. Route these cables through manholes and handholds in liquid tight flexible metal conduit.
H. Install conduit plumb and level, and parallel or perpendicular to structural members and surfaces. When two or more conduits are in the same general routing, install them parallel with symmetrical bends.
I. Install liquid tight flexible metal conduit with watertight connectors for final connections to dry type transformers, motors without flexible cords, other equipment with rotating or moving parts, and as shown on the Plans. Install liquid tight metal conduit without sharp bends and in minimum lengths required for the application, but no longer than six feet.

J. Conduits shall have end bells where terminated at wall or adapters for steel conduit continuations where required.

K. Conduits shall be installed within walls or slabs unless otherwise shown on the Plans.

L. The conduit stub-out for all valve actuators shall be physically arranged per Water Authority standards.

3.02 INTERIOR EXPOSED CONDUIT

A. When it is impossible to conceal conduits within walls or slabs, exposed interior conduit, located in structures that are entirely above finished grade shall be rigid galvanized steel with a minimum size of 3/4-inch diameter. For structures that extend below finished grade exposed interior conduit located in structures above three feet above finished grade shall be rigid galvanized steel with a minimum size of 3/4-inch. Exposed interior conduit located in structures at or below three feet above finished grade shall be PVC-coated rigid galvanized steel with a minimum size of 3/4 inch.

B. Rigidly support exposed conduit with stainless steel or galvanized hardware and framing materials, including nuts and bolts. Conduits attached to concrete or masonry surfaces shall be supported with a minimum 7/8-inch space between the conduit and supporting surface. All anchoring of conduit or supports to concrete or masonry surfaces shall be accomplished with stainless steel anchors. Provide a minimum 1/4-inch space between conduit attached to surfaces other than concrete or masonry. Conduit shall be installed with supports and provisions as required by the appropriate NEC article.

C. Install all interior exposed conduit at least six inches from high temperature piping, ducts, flues and the outside edge of structural openings and future openings.

D. Provide at least seven feet of vertical clearance for all horizontally installed conduit above accessible floor space, unless vertical clearance is already obstructed.

E. Provide flashing for conduits installed through roofs or metal walls and seal watertight.

3.03 EXTERIOR EXPOSED CONDUIT

A. Install PVC-coated rigid steel conduit in all exposed outdoor locations, except where emerging from an underground installation. Rigidly support conduit. Thread and install PVC-coated rigid steel conduit as recommended by the conduit manufacturer. Do not use steel conduit threading tools to thread PVC-coated rigid steel conduit.

B. Rigidly support exposed conduit with galvanized hardware, framing materials, and with stainless steel nuts and bolts. Conduits shall be supported with a minimum 7/8-inch space between the conduit and supporting surface. Provide a minimum 1/4-inch space between conduit attached to surfaces other than concrete or masonry. All anchoring of conduit or supports to concrete or masonry surfaces shall be accomplished with stainless steel anchors. Conduit shall be installed with supports and provisions as required by the appropriate NEC article.

3.04 ENCASED CONDUIT

A. Provide concrete encasement for all underground duct banks unless indicated otherwise on the Plans. Where conduits are concrete encased, provide a minimum separation of two inches between conduits. Minimum size for underground duct bank conduit is two-inch diameter.

B. Continue concrete encasement on exposed outdoor conduit risers to three inches above grade, with top crowned and edges chamfered.
C. Where conduit and concrete encasement are terminated underground, terminate steel conduit flush at the bulkhead with a coupling and a screw plug. Protect threads with a screw-in plastic cap. Form a 1-3/4 inch by 3/4 inch deep horizontal shear key in the concrete encasement above and below the embedded conduits. After concrete placement, clean conduit and bar connector ends and coat with two coats of thixotropic coal tar.

3.05 CONDUIT IN MASONRY OR CONCRETE WALLS

A. Conduit installed in masonry or concrete walls shall be rigid PVC. Minimum size of conduit shall be 3/4-inch diameter.

B. Install conduit between the reinforcing steel in walls or slabs that have reinforcement in both faces. In slabs that have only a single layer of reinforcing steel, install conduit under the reinforcement.

C. Install conduit expansion and deflection fittings across structural joints where structural movement is allowed.

D. Neatly group conduit into any openings cut or formed into concrete and masonry structures.

E. Routes of conduit that will emerge from concrete or masonry shall emerge as PVC-coated rigid steel conduit. Provide factory 90 degree elbows, as necessary, for emergence. Line bends will not be allowed. Provide a minimum of two inches of vertically plumb or horizontally level non-threaded length beyond the emergence for the continuing conduit run or application.

3.06 BURIED CONDUIT

A. Install rigid PVC for underground portions of conduit for power, control, intercommunication and instrumentation cables. Solvent weld all PVC conduit joints in accordance with the recommendations of the manufacturer.

B. Provide rigid PVC conduit for underground portions of telephone conduit, unless otherwise required by the telephone utility. Conduits shall have end bells where terminated at walls.

C. Install rigid PVC conduit where underground conduits are indicated not to be concrete encased.

D. For underground conduits and conduit banks, provide two foot minimum earth cover. Underground conduit bend radius shall be not less than two feet at vertical risers or less than three feet elsewhere. Slope underground conduits to drain away from buildings.

E. Underground conduit banks through building walls shall be cast in place, or concreted into boxouts with water stops on all sides of the boxout. Water stops shall conform to Section 03000, General Concrete Construction.

F. Conduits not encased in concrete and passing through walls that have one side in contact with earth are to be sealed watertight with special rubber-gasketed sleeve and joint assemblies or with sleeves and modular rubber sealing elements.

G. Place warning tape six inches above all buried conduit. Place a second warning tape above all buried conduit 12 inches below the finished grade. Install both warning tapes along the entire length of buried conduit, and extend tapes to be visible in all pull boxes. Place warning tape flat, parallel to and within three inches of the centerline of buried conduit.

H. Where uncoated portions of metallic conduits and associated bare metal fittings are exposed to earth, apply a corrosion resistant protective coating of thixotropic coal tar paint, extending one inch beyond the unprotected portions and fittings.
3.07 SEALING OF CONDUITS

A. After cable has been installed and connected, seal conduit ends with non-hardening sealing compound forced into conduits to a minimum depth equal to the conduit diameter. Seal all conduits at handholds, manholes, and building entrance junction boxes, and for one inch and larger conduit connections to equipment, in this manner.

3.08 CONDUIT IDENTIFICATION

A. Provide conduits with identification tags in manholes, handholds, building entrance pull boxes, junction boxes, and equipment. Identification tags shall be 19-gage stainless steel, with 1/2 inch stamped letters and numbers as indicated on the Plans. Attach identification tags to conduits with stainless steel tie wire, and position tags to be readily visible for inspection.

3.09 MANDREL

A. For raceways in buried and concrete-encased duct banks, after the concrete envelope has set, pull a mandrel of a diameter approximately 1/4 inch less than the raceway inside diameter, through each raceway. Then pull a bristle brush through each raceway to remove debris.

3.10 EMPTY CONDUIT

A. Provide 200 pound strength nylon pull cord in empty conduits with a minimum four feet knotted and coiled at each end. Provide permanent, removable cap over each end.

B. Provide PVC plug with pull tab for underground raceways with end bells.

C. Identify end points of raceway with waterproof tags attached to pull cord at each end, and at intermediate pull point.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. Furnish and install all wire, cable and appurtenances as indicated on the Plans and as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 16050 General Electrical Requirements

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Society for Materials and Testing

   ASTM B3 Specification for Soft or Annealed Copper Wire.
   ASTM B8 Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   ASTM B33 Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.

1.04 QUALIFICATIONS

A. Furnish wire and cable by manufacturers who are fully experienced, reputable, and qualified in the manufacture of the equipment to be furnished. Design, manufacture, and install the wire and cable in accordance with the best practices and methods.

1.05 SUBMITTALS

A. Samples of proposed wire and cable. Each sample shall have a legible and complete surface printing of the cable identification including the manufacturer, the size, type of insulation and voltage on the jacket. Accepted samples will be sent to the project location for comparison by the Engineer with the wire actually installed.

PART 2 - MATERIALS

2.01 GENERAL

A. Furnish copper conductors. Material and stranding of conductors must conform to ASTM B33, ASTM B3 and ASTM B8, for the appropriate class.

B. Provide stranded cable for all conductors, except equipment bonding conductors, which may be solid copper.

C. Identify all wires along their insulation, denoting size, type of insulation, and manufacturer's trade name.

D. Provide all wiring, including instrumentation and control wiring, with a 600 volt insulation rating. Provide wire in sizes up to No. four with colored insulation. Code wiring in sizes No. 4 and larger with colored tape along six inches of the insulation, at the point of connection to field devices, except for AC neutral (intentionally grounded) conductors. AC neutral (intentionally grounded) conductors, in sizes No. 4 and larger, shall be identified in accordance with NEC requirements.
E. Adequately protect cables to prevent physical damage and entry of water and other foreign materials during shipment and outdoor storage. Seal cable ends to exclude moisture by installing heat shrinkable plastic end seals.

F. Use cable-pulling lubricant compatible with all cable jackets. Lubricants shall be UL approved for use with the insulation specified. Do not use lubricants which contain wax, grease, or silicone. Lubricants shall be Polywater, “Type J,” or equal.

2.02 APPLICATIONS

A. For branch circuit power, control, indication, and alarm circuits operating at 600 volts or less, except where instrument cables are permitted or required, provide type THHN or MTW, stranded, 600 volt power cable.

B. For electronic circuits to instrumentation, metering, and other signaling and control equipment provide stranded two- or three-conductor instrument cable twisted for magnetic noise rejection, and protected from electrostatic noise by a total coverage shield.

C. For service entrance feeders operating at 600 volts or less, provide stranded type XHHW, 600-volt power cable.

D. Provide UL listed stranded hookup wire for valve actuator controls, intrusion alarm circuits and internal remote terminal unit wiring. Minimum conductor size is 18 AWG where the wire run between the device to be wired and the RTU is 200 feet or less. Minimum conductor size is 16 AWG where the wire run between the device to be wired and the RTU is more than 200 feet.

2.03 MINIMUM SIZES

A. Except for instrumentation and control wire, minimum conductor size is 12 AWG.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Handle all conductors carefully to avoid kinks or damage to insulation. Do not bend cables to a radius less than the manufacturer's recommended minimum bending radius. Do not pull cables tight against bushings nor press cables heavily against enclosures.

B. Use lubricants to facilitate wire pulling. Lubricants shall be UL approved for use with the insulation specified.

C. In conduits over one foot long, or conduits that have any bends, pull all cables in or out simultaneously.

D. Install shielded instrumentation wire in rigid steel conduit and pull boxes that contain only shielded instrumentation wire. Install shielded instrumentation wire from terminal to terminal with no splicing at any intermediate point.

E. Ground shielding on instrumentation wire at the RTU terminal strip end only.

F. Splice cables only at readily accessible locations. Twist-on wire connections may be used for ten AWG and smaller wire. Splice stranded cables of eight AWG and larger with crimp or compression type connectors.

G. Do not make splices to utilize short lengths of cable nor to provide correct lengths on cable initially cut too short for a particular circuit.
H. Make splices in power feed conductors with compression type connectors. Do not splice control or signal conductors.

I. Terminate stranded conductor cable by lugs, cup washers, or pressure type connectors. Do not wrap stranded cables around screw type terminals.

J. Use crimping hand tools that are made for securing the conductor in the compression type connectors or terminal lugs, for the conductor sizes involved. The crimping tools shall be of the ratchet type that prevents the tool from opening until the crimp action is completed. Crimping tools shall be a product of or approved by the connector manufacturer.

K. Lace control leads between conduit ends and terminal blocks located in control panels, cabinets and similar locations neatly together with non-releasing nylon ties.

L. Leave all spare conductors at their maximum length for possible use as replacements. Coil each spare conductor neatly and then secure to the conductors being used.

M. Remove wire that has been installed and is unacceptable and replace at no additional cost to the Water Authority.

N. Leave at least one foot of extra wire or cable inside the valve-actuator disconnect box to allow for maintenance of the disconnect plug.

O. Any wire or cable that has visible or suspected damage to the jacket or insulation shall be inspected using a megger or Hi-Pot tester to insure that the insulation meets manufacturers specifications. This testing shall be at the Engineer's request, and, at the Engineer's direction, shall include wet testing of the wires or cables. Any wire or cable that fails to meet manufacturers specifications for insulation resistance, or has visible damage to the jacket or insulation, shall, at the Engineer's direction, be replaced by the Contractor at no cost to the Water Authority.

3.02 CABLE IDENTIFICATION

A. Except for lighting and receptacle circuits, identify each individual wire in power, control, indication, and instrumentation circuits with markers at the point of termination. Conductors shall be color-coded as shown below. Follow Water Authority standard for color-coding of control wiring, as shown in Section 16160, Cabinets and Consoles.

<table>
<thead>
<tr>
<th>Phase</th>
<th>208Y/120V</th>
<th>480Y/277V</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Black</td>
<td>Brown</td>
</tr>
<tr>
<td>B</td>
<td>Red</td>
<td>Orange</td>
</tr>
<tr>
<td>C</td>
<td>Blue</td>
<td>Yellow</td>
</tr>
<tr>
<td>Neutral</td>
<td>White</td>
<td>Gray</td>
</tr>
<tr>
<td>Ground</td>
<td>Green</td>
<td>Green</td>
</tr>
</tbody>
</table>

B. Show the wire number on the equipment manufacturer's drawings.

C. Position wire markers to be readily visible for inspection.

D. Color-code power wires not having individualized identification numbers with electrical tape or colored wire jacket.

E. Identify all control wiring at each end with unique wire or cable markers.
F. Identify and mark all circuits in control panels, terminal cabinets, and pull boxes. Mark circuits in accordance with wiring diagrams submitted with shop drawings.

G. Identify and color code each phase of three phase power circuits at all terminations.

3.03 CABLE PLACEMENT

A. Immediately prior to the placement of each cable or cable group, inspect the raceway route to be followed and determine if the installation is complete and free of all materials detrimental to the cable or its placement. Group all cable assigned to a particular conduit and pull in simultaneously, using cable grips and acceptable lubricants.

B. Provide adequately sized raceways to accommodate the number and size of cables as specified herein, in accordance with Article 300 of the National Electric Code. If at anytime during the progress of the work raceways appear inadequate to accommodate the assigned cable, notify the Engineer at once and discontinue any further work on the questionable raceway until advised by the Engineer as to how to proceed.

C. Check all cable carefully both as to size and length before pulling into conduits. Remove cable pulled into the wrong conduit or cut too short and replace at no additional cost to the Water Authority. Do not reuse cable removed from one conduit or duct without permission of the Engineer.

D. Accomplish fishing and pulling with flexible round metal or non-metallic tape, carbon dioxide or forced air propelled polyethylene cord, nylon rope, or manila rope.

E. Use woven wire cable grips to pull all single conductor cable, No. 2/0 and larger, and all multi-conductor cable. Use pulling loops to pull single conductor cable smaller than No. 2/0. When a cable grip is used for pulling, cut off the area of the cable covered by the grip plus six inches and discard.

F. Do not exceed the maximum pulling tension recommended by the cable manufacturer. Use only those pulling mechanisms of both the manual and power types with the rated capacity in tons clearly marked on the mechanism. Whenever the capacity of the pulling mechanism exceeds the recommended pulling tension of the cable as given by the cable manufacturer, use a dynamometer to show the tension on the cable and watch the indicator constantly. If any excessive strain develops, stop the pulling operation at once, determine the difficulty and make corrections.

3.04 TESTS - 600 VOLT WIRE

A. After all terminations at any transformers, equipment, panels, enclosures, etc., are finished, verify the installation by producing a 1-2-3 rotation on a phase sequence meter when connected to “A,” “B,” and “C” phases.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION
A. This section describes furnishing, installing, field testing, and placing in operating condition, wiring devices as indicated on the Plans and as specified herein.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS
A. National Electrical Manufacturers Association
B. Federal Specifications
   W-S-896-F Switch, Toggle, Single Unit with wall (1P-ZP-3W) plates for switches and receptacles.
C. Underwriters' Laboratories, Inc.:
   UL-20 General Use Snap Switches.
D. National Fire Protection Association:
   NFPA 70 National Electrical Code.

1.03 SUBMITTALS
A. Shop drawings showing complete construction details and ratings of devices furnished under this section.

PART 2 - MATERIALS

2.01 LISTING
A. Provide all devices with UL label.

2.02 MANUFACTURERS
A. Use of a manufacturer's name, model, or catalog number is for purpose of establishing standard of quality and general configuration desired.
B. The following are acceptable manufacturers: Appleton, Crouse-Hinds, Pass & Seymour, Harvey Hubbel, or equal.

2.03 MATERIALS AND COMPONENTS
A. Provide general use, snap wall switches for alternating current in flush device boxes or surface mounted FS or FD cast outlet boxes, totally enclosed in composition case, with insulated mounting yoke and sidewired, binding screw-type terminals. Provide single-pole, two-pole, three-way, or four-way switches as indicated on Plans.
B. Provide switches on AC lighting circuits rated at 20 amperes, 120/277 volts. Acceptable devices are Hubbell model "1221" through model "1224" or approved equal.
C. Provide receptacles rated 20 ampere, 125 volt, three wire, duplex of grounding type in composition case with insulated mounting yoke, back and side-wired with binding screw-type terminals. Provide NEMA 5-20R duplex receptacles as manufactured by Harvey Hubbell, model "5362" or approved equal.

D. Provide weatherproof devices rated 20 ampere, 125 volt, consisting of duplex receptacles with spring-loaded, soft-gasketed hinged covers with stainless steel spring.

2.04 DEVICE PLATES

A. Use galvanized or cadmium plated device plates on surface-mounted outlet boxes where weatherproof plates are not required.

B. Provide Type 302 stainless steel device plates on flush-mounted outlet boxes where weatherproof plates are not required.

C. Provide countersunk device plate mounting hardware finished to match the plate.

D. Provide device plates for switches outdoors that have provisions for padlocking switches "ON" and "OFF", as manufactured by Appleton, model FSK-1VS or Crouse-Hinds, model DS185.

E. Provide device plates for receptacles outdoors manufactured by Appleton, model FSK-WRD or Crouse-Hinds, model WLRD1.

F. Provide flush-mounted, weatherproof plates with adapter plates, as manufactured by Appleton, model FSK-SBA or Crouse-Hinds, model FS031.

G. Provide engraved device plates, manufactured by Sierra Electric Corporation or approved equal.

H. Provide nameplates or equivalent markings on switch enclosures to indicate ON and OFF positions of each switch. ON and OFF for three-way or four-way switches are not acceptable.

PART 3 - EXECUTION

3.01 CONNECTION AND MOUNTING

A. Rigidly attach wiring devices, as indicated on the Plans, avoiding interference with other equipment.

B. Securely fasten nameplates using screws, bolts, or rivets centered under or on the device.

3.02 INSTALLATION

A. Mount wall switches 48 inches above finished floor or grade to the top of switch.

B. Install convenience outlets 48 inches above the finished floor or grade to the top of the device.

C. Mount wall thermostats 66 inches above the floor unless otherwise required. Provide suitable insulation from wall temperature for thermostats mounted on exterior walls.

D. Install telephone outlets 48 inches above the finish floor unless otherwise required.

E. Mount receptacles in flush device boxes or surface mounted FS or FD cast boxes.

F. All freestanding hardware must be securely mounted; conduit is not an acceptable support.
3.03 GROUNDING

A. Ground all devices, including switches and receptacles in accordance with NEC, ART. 250.

B. Ground switches and metal plates through switch mounting yoke, outlet box, and raceway system.

C. Ground flush receptacles and metal plates through positive ground connection to outlet box and grounding system. Maintain ground to each receptacle by spring-loaded grounding contact to mounting screw, or by grounding jumper, both making positive connection to outlet box and grounding system at all times.

3.04 CHECKOUT AND TESTING

A. After circuits are energized, test wall switches for proper operation.

B. After circuits are energized, test each receptacle, correct polarity, and test each GFI receptacle for proper operation.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section describes the furnishing of materials, testing, and installing of the cabinets and consoles as indicated on the Plans and as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 16050 General Electrical Requirements
B. Section 16940 General Instrumentation System Requirements

1.03 SUBMITTALS

A. Shop drawings, product data, and descriptive literature for materials, equipment, and other items as specified. Include the manufacturer's name, product designation, and catalog numbers. Indicate enclosure type, mounting provisions and wiring diagrams.

B. Control panel interior and exterior elevations, panel layout, terminal block rail assemblies, and internal wiring.

C. One pint of touchup spray paint in accordance with the manufacturer’s specifications.

PART 2 - MATERIALS

2.01 CONTROL PANEL

A. Provide a NEMA 12 enclosure suitable for a damp and dusty environment for the control panel. Include 12 inch floor stands welded to the enclosure and heavy-duty lifting eyes. Provide access doors with neoprene gaskets and three-point keylock handles. Handles shall be keyed for current Water Authority keylock. The Water Authority will provide lock information to the manufacturer. Refer to the Plans for enclosure size and details.

B. Construct control panel cabinets from formed 12-gauge steel. Grind all exposed edges and welds on the enclosure smooth. Paint the exterior of the enclosure with a rust-inhibiting primer and two coats of epoxy paint. Provide two formed 12-gauge steel subpanels for attaching surface-mounted components inside the cabinet. Attach all components with screws and include threaded connectors on the subpanel. Do not use rivets or back of panel nuts.

C. Equip each interior with a fluorescent lamp. Install a combination cooling fan package and exhaust grille with air filters and aluminum covers per the manufacturer's recommendations. Install a Phoenix Contact Inc. part number 5603173-SDCWA Power Rail Assembly, no exceptions. Paint the interior with two coats of white gloss enamel.

D. Control panel cabinet shall be A-604820-LP, as manufactured by Hoffman Corporation, or equal.

2.02 COMMUNICATIONS CABINET

A. Provide a communications cabinet sized 72 x 24 x 18 inch floor standing NEMA 12 enclosure with panel suitable for a damp and dusty environment. Provide access doors with neoprene gaskets and keylock latches as required for control cabinets.
B. Construct cabinet from formed 16-gauge steel. Grind all exposed edges and welds on the enclosure smooth. Paint the exterior of the enclosure with a rust-inhibiting primer and two coats of epoxy paint. Provide mounting brackets for future fiber-optic hardware by others inside the cabinet.

C. The communications cabinet shall be a Hoffman Corporation model A-722418FS, or equal.

2.03 INTERFACE PANEL

A. Provide an interface panel as a 20 x 12 x 8 inch wall-mounted NEMA 12 enclosure with back panel suitable for a damp and dusty environment. Provide hinged access doors with neoprene gaskets, door clasps, and a hasp and staple for padlocking.

B. Construct cabinet from formed 14-gauge steel. Grind all exposed edges and welds on the enclosure smooth. Paint the exterior of the enclosure with a rust-inhibiting primer and two coats of epoxy paint.

C. The interface panel shall be as manufactured by Hoffman Corporation, or equal.

D. Terminal Blocks: Provide terminal blocks of high-density type molded plastic with barriers and box lug terminals rated 25 amperes at 300 volts. Provide white marking strips, fastened securely to the molded sections with printed wire numbers or circuit identifications. Terminal blocks shall be Phoenix Contact Type UK with mounting rack, or equal.

2.04 CONTROL PANEL CIRCUIT DEVICES AND COMPONENTS

A. General: Mount all components, except those on the doors, on fixed or swing-out panels. Mount terminal blocks for field connections per the installation details and provide clearance for conduit entry. Locate fixed panels so as not to prevent access within the cabinets to other components, wiring, and terminal blocks on fixed panels or front panels.

B. Space for Future Equipment: Provide space in the panel for future equipment installations, including panel indicators, hand switches, isolation amplifiers, circuit breakers, terminal blocks, and any other equipment or appurtenances as described. Refer to the Plans for face panel layout. Make cutouts for future panel face mounted instruments shown on the Plans for Water Authority RTU front panel during panel fabrication. Cover rectangular cutouts with phenolic material. Cover circular knock-outs with Cutler Hammer removable hole plugs.

C. Control Relays: Provide DIN-rail mounted control relays with solid state 3-30 volt DC trigger circuits. Provide minimum output ratings of 35 ampere, 330 volt AC output. All relays shall be of one manufacturer. Use Omega model SSRINT660DC50, or Crydon model CMRD2435, or equal.

D. Circuit Breakers: Provide single-pole, 120 volt circuit breakers. Protect all power sources by circuit breakers, including UPS power. Circuit breakers shall be Square D Company, no exceptions.

E. Wire Marking: Designate each signal and circuit conductor connected to a given electrical point by a single unique number which shall be shown on all shop drawings. Mark these numbers on all conductors at every terminal using white numbered wire markers of plastic-coated cloth, Brady Type B-500, Thomas & Betts "E-Z Code," or equal; or use permanently marked heat-shrink plastic. Use the Water Authority standard color code for each signal conductor, as shown on the Plans.

F. Terminal Blocks: Provide terminal blocks of high-density type molded plastic with barriers and box lug terminals, with a rating of 25 amperes at 300 volts. Provide white marking strips, fastened securely to the molded sections with printed wire numbers or circuit identifications. Terminal blocks shall be Phoenix Contact Type UK with mounting rack. A typical terminal block diagram for Type I and II control panels is shown on the Plans.
G. Surface Mount Wiring Duct: Provide slotted wall wiring duct with snap-in surface mount and solid snap-on cover in sizes shown on the Plans. Provide Panduit E Type, or equal.

H. Receptacle Bar: Provide receptacle bar with four 3-prong household outlets and surge protection on the three conductors of the power source through two isolated filter banks. Provide Isobar 4, or equal.

I. Receptacles: Provide molded composition, ivory, specification grade duplex receptacles. Duplex receptacles for 120 volt, single-phase, three wire service to be rated 20 amperes, 125 volts, back or side wired, NEMA Type 5-20R. The receptacles shall be Hubbell No. 5362-I.

J. Hand Switches and Valve Limit Switch Indicators at Interface Cabinet: Provide an indicating rotary hand switch to perform the function shown. Provide unit of industrial quality, oiltight grade with 10-ampere contacts. Hand switches and indicators shall have legends as shown on the Plans. Provide indicator lights with 120 volt AC, six watt lamps, Cutler-Hammer Model 10250T-231N with appropriate color lens. Hand switches on the control panel cabinet shall be Cutler-Hammer Model 10250T-15235.

K. Isolation Amplifier Module (Signal Converter): Provide an isolation amplifier which accepts a standard four to 20 mA DC input signal and provides a completely isolated four to 20-mA DC output. Calibration shall be plus or minus 0.1 percent of span (linearly and repeatability). Provide unit that is surface mounted, of the plug in type, and utilizes all solid state components. Isolation amplifiers shall be Phoenix Contact Model MCR-CPSS-I/I-44-E, no exceptions.

L. Digital Display/Remote: Provide a digital display readout that accepts RS232 communication input. Manufacturer shall be Nematron, model IWS-30M or latest upgrade, no exception.

2.05 CONTROL CIRCUIT WIRING

A. Provide instrumentation signal cables of the type used for process control with shielded pairs or triads with polyvinyl jacket and overall shield over the multiple pairs or triads. Provide instrumentation cable rated for 600 volts at 90 degrees C or better. The size of the instrumentation cable shall be AWG No. 18 with seven strands minimum. Conductor colors shall be black and clear for single pairs, or black, white, and red for triads.

B. Provide 120 volt AC wiring within the panel using AWG No. 18 hook-up wire, UL Type 1015.

C. Make up wiring run from components on a wing-out panel or door to other components on a fixed panel in tied bundles. Tie bundles with nylon wire ties and secure to panels at both sides of the "hinge loop" so that conductors are not strained at terminals.

D. Tie wiring run to control devices on the front panels together at short intervals and secure to the inside face of the panel using panel screw tiedowns at six inch intervals.

E. Run wiring to rear terminals on panel-mount instruments in plastic wireways secured to horizontal brackets run above or below the instruments in about the same plane as the rear of the instruments, as shown on the Plans.

F. Install signal conditioners and control interface relays wherever proper instrument interfacing dictates use of these components. Isolate all signals terminated in the Interface Panel to prevent corruption of Water Authority RTU signals. Assign a tag number to each auxiliary device and indicate each on the panel shop drawings.

G. Identify all electrical devices within the panel by tag number, machine printed on a label visible from the panel interior. Provide labels of precut cloth with an adhesive backing. Provide labels with rounded corners that are consistent in size throughout the panel.
H. Secure all cabinets and consoles to the supporting structure in a rigid manner.

PART 3 - EXECUTION

3.01 WIRES

A. Wire main power (120 volt AC) to the RTU, lights, equipment and other panels using color coded AWG No. 12 wire. Provide a six receptacle power outlet strip with surge suppression, 15A/125VAC, 60 Hz, 1875 watts continuous duty, with no on/off switch. Provide AC power to all peripheral system equipment power supplies mounted in the RTU cabinet using molded three-wire plug cords.

B. Color code RTU wiring in accordance with the following:

<table>
<thead>
<tr>
<th>Signal Definition</th>
<th>Wire Color RTU Panel Side</th>
<th>Wire Color RTU Field Side</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flowmeter 1</td>
<td>Shielded</td>
<td>Shielded</td>
</tr>
<tr>
<td>Flowmeter 1</td>
<td>Shielded</td>
<td>Shielded</td>
</tr>
<tr>
<td>Motor Run Valve 1</td>
<td>Orange</td>
<td>Orange</td>
</tr>
<tr>
<td>Motor Run Valve 2</td>
<td>Orange on White</td>
<td>Orange on White</td>
</tr>
<tr>
<td>Valve 1 Open Limit</td>
<td>Yellow on Brown</td>
<td>Yellow on Brown</td>
</tr>
<tr>
<td>Valve 2 Open Limit</td>
<td>Yellow/White on Brown</td>
<td>Yellow/White on Brown</td>
</tr>
<tr>
<td>Valve 1 Close Limit</td>
<td>Blue on Brown</td>
<td>Blue on Brown</td>
</tr>
<tr>
<td>Valve 2 Close Limit</td>
<td>Blue/White on Brown</td>
<td>Blue/White on Brown</td>
</tr>
<tr>
<td>Valve 1 Position</td>
<td>Shielded</td>
<td>Shielded</td>
</tr>
<tr>
<td>Valve 2 Position</td>
<td>Shielded</td>
<td>Shielded</td>
</tr>
<tr>
<td>Valve 1 Close Signal</td>
<td>Blue</td>
<td>Blue</td>
</tr>
<tr>
<td>Valve 2 Close Signal</td>
<td>Blue on White</td>
<td>Blue on White</td>
</tr>
<tr>
<td>Valve 1 Open Signal</td>
<td>Yellow</td>
<td>Yellow</td>
</tr>
<tr>
<td>Valve 2 Open Signal</td>
<td>Yellow on White</td>
<td>Yellow on White</td>
</tr>
<tr>
<td>PSI 1 Upstream</td>
<td>Shielded</td>
<td>Shielded</td>
</tr>
<tr>
<td>PSI 2 Upstream</td>
<td>Shielded</td>
<td>Shielded</td>
</tr>
<tr>
<td>PSI 1 Downstream</td>
<td>Shielded</td>
<td>Shielded</td>
</tr>
<tr>
<td>PSI 2 Downstream</td>
<td>Shielded</td>
<td>Shielded</td>
</tr>
<tr>
<td>HOA 1 in Auto</td>
<td>Grey on White</td>
<td>Tan</td>
</tr>
<tr>
<td>HOA 1 in Auto</td>
<td>Grey on White with Tag</td>
<td>Tan with Tag</td>
</tr>
<tr>
<td>Bypass Meter 1</td>
<td>Shielded</td>
<td>Shielded</td>
</tr>
<tr>
<td>Bypass Meter 1</td>
<td>Shielded</td>
<td>Shielded</td>
</tr>
<tr>
<td>Power OK</td>
<td>Shielded Wire</td>
<td>Black</td>
</tr>
<tr>
<td>Intrusion</td>
<td>Grey</td>
<td>Grey</td>
</tr>
<tr>
<td>+24 Volt DC</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>-24 Volt DC</td>
<td>Green on White</td>
<td>Green on White</td>
</tr>
</tbody>
</table>
3.02 FABRICATION

A. Complete, assemble, wire, and test each control and terminal cabinet at the factory. Test in accordance with the latest UL and NEMA Standards. Provide UL label as applicable on all cabinets.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes the furnishing, installing and testing of a safety socket can as indicated on the Plans and as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 16050 General Electrical Requirements
B. Section 16470 Panelboards

1.03 SUBMITTALS

A. Shop drawings or data showing ratings and characteristic including voltage ratings, bussing arrangement, continuous current ratings, fault current withstand ratings, neutral bus rating, enclosure type, rating of overcurrent protective device, and mounting provisions.
B. Outline and dimensional drawings and conduit entry restrictions.

PART 2 - MATERIALS

2.01 GENERAL

A. Provide a safety socket can with a separate pull section, a circuit breaker as a main disconnect, and a metering compartment. The unit shall be approved by the local electric utility.

2.02 CABINET

A. Provide cabinet constructed from sheet metal with hinged front doors, catches and locks. All metal surfaces shall be factory primed and finished. Cabinet shall be NEMA 3R Type enclosure.

2.03 CIRCUIT BREAKER

A. Provide a circuit breaker of trip rating as shown on the Plans and interrupting capacity not less than available short circuit current.

2.04 LISTING

A. Provide UL listed unit, rated for continuous duty.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install securely where shown on the Plans, in accordance with the NEC, and at a height acceptable to the electric utility.
3.02 INTERIOR

A. Provide line and load connectors, meter socket with the required number of terminals, and factory installed test bypass facilities.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section describes furnishing and installing a complete grounding system in accordance with Article 250 of the National Electrical Code, as indicated on the Plans and as specified herein.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Society for Materials and Testing

ASTM B3 Specification for Soft or Annealed Copper Wire.

ASTM B8 Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

ASTM B33 Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.

2002 NEC Section 250, Grounding.

1.03 SUBMITTALS

A. Manufacturers’ catalog sheets with catalog numbers marked for the items furnished, which shall include:

1. Exothermic welding materials

2. Terminal lugs and clamps

3. Copper ground cable

4. Ground rods

5. Ground connection hardware

PART 2 - MATERIALS

2.01 GROUNDING CONDUCTORS

A. Provide bare or green insulated grounding conductors in accordance with the National Electrical Code, soft drawn copper cable or bar, not smaller than 12 AWG.

B. Identify six AWG and larger insulated conductors used for grounding with green electrical tape. Spiral tape around conductor for its entire length or exposed length in boxes or when emerging from protective conduits.

2.02 GROUNDING CABLES

A. Provide soft temper, high conductivity, copper grounding cable, meeting standards ASTM B8 for stranded cable.
2.03 GROUNDING ELECTRODES

A. Provide grounding electrodes of copper clad steel rods, 3/4 inch diameter, not less than eight feet long. Ground rods shall be Copperweld-brand, or approved equal.

2.04 EXOTHERMIC WELDS

A. Provide grounding cable splices and joints which will be inaccessible upon completion of construction in accordance with the requirements of IEEE Standard 837. Use Cadweld "Exothermic" or Burndy "Hyground" type.

B. Provide molds, cartridges, materials, and accessories as recommended by the manufacturer of the molds for the items to be welded. Furnish molds and powder from the same manufacturer. Equipment shall be as manufactured by Cadweld, or approved equal.

2.05 GROUND CONNECTION HARDWARE

A. Provide ground connection hardware, bolts and nuts of high strength, high conductivity copper alloy.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install grounding electrode conductors in accordance with the Plans. Bond the protecting conduits to the grounding electrode conductors at both ends. Do not allow the points of connections to be painted.

B. Install grounding conductors with all three phase feeders.

C. Install grounding conductors with all single phase branch circuits.

D. Fit conduits stubbed-up below a switchgear or motor control center with insulated grounding bushings and connected to the equipment ground bus. Size the grounding wire in accordance with Table 250-95 of the National Electrical Code, except that a minimum No. 12 AWG shall be used.

E. Install bonding jumpers in liquidtight flexible metal conduit in sizes 1-1/2 inch and larger and in any size flexible conduit longer than four feet.

F. Ground all equipment enclosures, motor and transformer frames, conduits systems, cable armor, exposed structural steel, and similar items.

G. Make grounding connections to equipment and ground buses with copper ground lugs or clamps. If enclosures are not provided with ground buses or ground terminals, use clamp type lugs added under permanent assembly bolts or by grounding locknuts or bushings. New assembly bolts may not be installed by drilling enclosure if the drilling will change the manufacturers rating of the enclosure.

H. Ensure good ground continuity, in particular between the conduit system and equipment frames and enclosures. Where necessary, install jumper wires.

I. Install grounding cable through building exterior walls within three feet below finish grade and install a water stop. Fill the space between the strands in the cable with solder and solder a 12 inch copper disc over the cable, to provide a waterstop.

J. Install grounding cable near the base of a structure in earth and as far from the structure as the excavation permits and no closer than six inches.
K. Provide exothermic welds between grounding cable installed for building ground grid and each ground electrode in the ground grid system.

L. Form grounding conductors on equipment to the contour of the equipment and firmly support.

M. Use exothermic welds for all grounding cable connections to ground rods.

3.02 LIGHTING AND RECEPTACLES

A. Ground lighting fixtures by a bare or green insulated copper conductor in addition to the conduit system grounding connection.

B. Ground convenience outlet receptacles by a bare or green insulated copper conductor in addition to the conduit system grounding connection.

3.03 FIELD TESTS AND INSPECTION

A. Test all exothermic weld connections by striking the weld with moderate hammer blows. Remake any connection which fails such test or which, upon inspection, indicates a porous or deformed weld.

B. Provide exothermic welds which encompass 100 percent of the ends of the materials being welded. Remake welds which do not meet this requirement.

C. Test the completed grounding system with calibrated test equipment specifically designed to test grounding systems. Provide at least 48 hours notice of this test to the Engineer, to allow Water Authority personnel to witness the test.

D. The impedance of the ground system must be less than two ohms. If the measured impedance exceeds two ohms, make approved modifications to the grounding system until the impedance is below two ohms.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section describes furnishing, installing, and testing ventilated dry-type transformers as shown on the Plans and as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 16050 General Electrical Requirements

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Underwriters' Laboratories, Inc.:

UL 506 Transformers, Specialty.

B. National Electrical Manufacturers Association:

ST 20 Dry-Type Transformers for General Applications (ANSI C89.2).

C. National Fire Protection Association:

NFPA 70 National Electrical Code.

1.04 SUBMITTALS

A. Shop drawings showing outline dimensions and mounting provisions of the equipment, catalog designations, approximate weights of the assemblies, location and size of the conduit terminations, and wiring diagrams.

B. Typical audible-sound-level shop test results, signed and dated by factory trained service engineer.

C. List of special tools needed for erection, maintenance and adjustment of the equipment.

D. Manufacturer's data and factory and/or field test results in operation and maintenance manuals.

E. One pint container of paint for field touch-up in accordance with the manufacturer's specifications.

PART 2 - MATERIALS

2.01 TRANSFORMERS

A. Furnish general purpose dry-type transformers in indoor enclosure. For single-phase transformers and three-phase transformers above nine kVA, provide not less than two windings per phase. Auto transformers in place of general purpose dry-type transformers are not acceptable.

B. Furnish at least two taps of 2.5 percent full capacity above and below nominal in high voltage winding for transformers rated above 15 kVA. Furnish two, five percent taps below rated voltage for transformers rated 15 kVA and below.

C. Furnish three-phase transformers, Delta-Wye connected, conforming with latest NEMA standards. Furnish transformers with kVA ratings as indicated on the Plans.
D. Furnish transformers with primary and secondary voltages as indicated on the Plans, and secondary windings neutral brought out.

E. Furnish transformers that operate on a frequency of 60 Hz.

F. Furnish transformers manufactured for continuous operation at rated kVA with normal life expectancy as defined in NEMA Standard 20. Obtain performance without exceeding 115 degrees C average temperature rise by resistance or 145 degrees C hot spot temperature rise in 40 degrees C maximum ambient and 30 degrees C average ambient. Maximum coil hot spot temperature shall not exceed 185 degrees C.

G. Furnish transformers with 220 degrees C insulation materials for 15 kVA transformers and above. Furnish 185 degrees C insulation on transformers below 15 kVA.

H. Furnish core mounting frames and enclosures of welded and bolted construction to withstand shipping, erection, and short circuit stresses of 25 times normal load current for two seconds.

I. Furnish transformers manufactured to meet UL thermal overload test of 200 percent of rated current for one half hour.

J. Furnish transformers enclosures not to exceed the 65 degrees C rise established by UL as safe limit for maximum surface enclosure temperature.

K. Furnish transformers with sound level not exceeding the following:

<table>
<thead>
<tr>
<th>Transformer Rating (kVA)</th>
<th>Average Sound Level (dB) NEMA ST 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 09</td>
<td>40</td>
</tr>
<tr>
<td>10 – 50</td>
<td>45</td>
</tr>
<tr>
<td>51 – 150</td>
<td>50</td>
</tr>
<tr>
<td>151 – 300</td>
<td>55</td>
</tr>
<tr>
<td>300 – 500</td>
<td>60</td>
</tr>
</tbody>
</table>

L. Furnish transformers with sound levels greater than 50-dB with resilient vibration isolating mounts to prevent amplification of sound.

M. Furnish dry-type transformers as manufactured by General Electric Company, Square D Company, Westinghouse Electric Corporation, or approved equal.

N. Furnish transformers with an attached nameplate that lists rated input current, output current, frequency, primary and secondary voltages, impedance, and power rating in kVA.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install and guard transformers as specified by latest NEC and ANSI standards, and in accordance with manufacturer's instructions.

B. Furnish adequate space around transformer to dissipate transformer full load heat losses by ventilation without creating excessive operating temperature.

C. Mount transformers rated 15 kVA and below on the wall and mount transformers rated above 15 kVA on the floor.
D. Provide lifting lugs and jacking plates on transformer enclosure.

E. Furnish and install supports for transformers.

3.02 CHECKOUT AND TESTING

A. Field test all factory and field installed terminal connections for proper torque as recommended by manufacturer before energizing transformer.

B. Field test transformer primary and secondary voltages to verify voltages are in accordance with manufacturer's standards.

C. Field test transformer secondary voltage and adjust tap settings to provide secondary voltage as indicated on the Plans.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

   A. This section describes furnishing and installing panelboards including circuit breakers, accessories and cabinets complete as shown on the Plans and as specified herein.

   B. Panelboards are to be in conformance with the latest NEMA Standards and Federal Specifications listed below.

1.02 RELATED WORK SPECIFIED ELSEWHERE

   A. Section 16050 General Electrical Requirements

1.03 REFERENCE SPECIFICATION, CODES, AND STANDARDS

   A. National Electrical Manufacturers Association

      PB1 Panelboards.

      AB1 Molded Case Circuit Breakers.

   B. Federal Specifications

      W-P-115B Panel, Power Distribution.

      W-C-375B Molded Case Circuit Breakers.

   C. National Fire Protection Association

      NFPA-70 National Electrical Code.

   D. Underwriter's Laboratories, Inc.

      UL 67 Panelboards.

      UL 489 Branch Circuit and Service Circuit Breakers.

1.04 SUBMITTALS

   A. Shop drawings showing outline dimensions and proposed circuit arrangements of the specified equipment. Include catalog designations, approximate weights of the assemblies, and schematic wiring diagrams.

   B. Time-current characteristic curves and data for each circuit breaker type and rating.

   C. List of tools needed for erection and adjustment of the equipment.
PART 2 - MATERIALS

2.01 PANELBOARDS

A. Panelboards shall be manufactured by Square D Company, no exception. Panelboards shall have combination bussing for bolt-on or snap-in type breakers.

B. Furnish factory assembled deadfront type panelboards.

C. Furnish panelboards complete with branch circuit breakers and a main circuit breaker or main lugs as indicated on plans.

D. Furnish three-phase, four-wire panelboards with a separate insulated neutral bus and separate ground bus.

E. Furnish panelboards with the voltage, frequency, and current ratings as indicated on the Plans.

F. Furnish the panelboard main and neutral busses with minimum 98 percent conductivity, rectangular copper bars, provided with bolted type lugs.

G. Provide drilled busses to fit either "A", "B" or "C" Phase connectors so that connectors are interchangeable and installed in a distributed phase sequence.

H. Furnish full-size neutral bars that include field mounted bonding jumper in panelboards connected to a three-phase, four-wire service. Arrange bus bar taps for panels with single pole branches for sequence phasing of the branch circuit devices. Phase bussing shall be full height without reduction. Cross connectors shall be copper.

I. Provide terminal lugs which are prevented from turning per NEMA standard PB1. Lugs are to be compatible with the conductor material and size.

J. Design interiors so that circuit breakers can be replaced without disturbing adjacent units and without removing the main bus connectors and so that circuits may be changed without machining, drilling, or tapping.

K. Arrange branch circuits using double row construction. Branch circuits shall be numbered by the manufacturer.

L. Furnish neutral bussing with a suitable lug for each outgoing feeder requiring a neutral connection.

M. Furnish panelboards with equipment grounding bus bonded to panelboard enclosure.

N. Provide main bus-bracing for each panel board adequate for the symmetrical short circuit current that will be available at the terminals as specified by the power company and the equipment location. Minimum bracing shall be adequate for 22,000 symmetrical short circuit current amperes at 240 volts.

O. Provide typed panelboard directory cards with the following information:

1. Panelboard name designation.
2. Panelboard voltage rating.
3. Panelboard ampere rating.
5. Panelboard pole/circuit numbers and branch circuit description as wired in the field.

6. Indicate two pole and three pole branch circuit breakers.

7. Label spare circuit breakers "spare".

P. Furnish service entrance panelboard suitable for use as service equipment with voltage, frequency and current ratings as indicated on the Plans. Provide service entrance panelboard with solid/neutral bus bar for grounding neutral conductor and equipment grounding conductor.

2.02 CIRCUIT BREAKERS

A. Furnish bolt-on type fully rated branch and main circuit breaker for circuits 60 amperes and greater. Furnish frame sizes, trip settings and number of poles as indicated on the Plans. Provide circuit breakers marked with ampere trip rating that can be read at a distance of two feet from the panel.

B. Furnish all breakers with quick-make, quick-break, toggle mechanisms; thermal-magnetic, inverse time-limit overload; and instantaneous short circuit protection on all poles. Provide indication of automatic tripping by the breaker handle assuming a distinctive position from the manual ON and OFF position. Furnish breaker handles that are trip-free on overloads.

C. Provide space for future breakers as indicated on the Plans.

D. Single pole breakers with handle ties or nails in lieu of multiple breakers are not acceptable.

E. Furnish handle lock device on breakers to prevent the manual opening of the selected breakers.

F. Furnish padlocking device on breakers to prevent the opening of breakers.

G. Furnish breakers up to 240 volts with interrupting rating not less than 10,000 amperes.

H. Furnish single pole, 20 ampere breakers in AC lighting panel.

I. Voltage and interrupting rating of all breakers in a panelboard shall not be less than the voltage and short circuit rating of the panelboard main buses. Furnish breakers to operate at a frequency of 60 Hz.

J. Furnish ground fault interrupter circuit breakers as indicated on Plans, or for any circuit serving receptacles outdoors, or in a wet/damp area.

K. Furnish single-pole breakers with full module size. Two pole breakers in a single pole's module are not acceptable.

L. Provide spare circuit breakers equal to 20 percent of the total installed in the panelboard.

2.03 CABINETS

A. Provide NEMA One cabinets without knockouts.

B. Provide panelboard cabinets of code-gauge galvanized, sheet steel and equip with gutters of ample size for the risers and outgoing circuits. Cabinets shall not exceed 78 inches in height. Provide surface of flush mount covers as required.

C. On cabinets 48 inches high and over provide a three-point latch assembly latching at top, bottom and middle.

D. Provide cabinets drilled only for the exact conduit entrances and mounting bolts.
PART 3 - EXECUTION

3.01 INSTALLATION

A. Mount panelboards such that the height of the top operating handle does not exceed 78 inches from the floor. Provide and install conduit and wiring to lighting transformer or motor control center as indicated on the Plans.

B. Surface mounted panelboards shall be mounted on 7/8-inch galvanized unistrut. Mount unistrut to concrete or masonry surfaces with stainless steel anchors.

3.02 SHOP PAINTING

A. Paint panelboards in accordance with manufacturer's recommendation.

B. Provide cabinet fronts, trims, and surface-mounted boxes finished in ANSI No. 61, light-gray enamel over a rust-inhibitive primer. Provide the fronts (exterior trims) attached to the boxes or interior trims, by quarter-turn, trim clamps.

C. Provide one 16-ounce spray can of Square D gray touch-up paint.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section describes furnishing, installing and testing complete indoor and outdoor lighting fixtures and systems in the fixture schedule as indicated on the Plans and as specified herein.

1.02 REFERENCE, SPECIFICATIONS, CODES, AND STANDARDS

A. Underwriters Laboratories, Inc

UL 20  General Use Snap Switches.
UL 773  Plug in, Locking Type Photo controls for Use with Area Lighting.
UL 773A  Nonindustrial Photoelectric Switches for Lighting Control.
UL 924  Emergency Lighting and Power Equipment.
UL 935  Fluorescent Lamp Ballasts.
UL 1029  High Intensity Discharge Lamp Ballasts.
UL 1570  Fluorescent Lighting Fixtures.
UL 1572  High Intensity Discharge Lighting Fixtures.

B. National Fire Protection Association

NFPA 70  National Electrical Code.

C. National Electrical Manufacturers Association

FA 1-73 (R79)  Outdoor Floodlighting Equipment.
SH 5-69 (R79)  Tubular Steel, Aluminum, and Prestressed Concrete Roadway Lighting Poles.

D. American National Standards Institute

C81.20  Electric Lamp Bases and Holders, Fluorescent Types.
C81.10  Electric Lamp Bases and Holders, Screw-Shell Types.
C82.1  Ballasts for Fluorescent Lamps.
C82.2  Fluorescent Lamp Ballasts Methods of Measurement.
C82.4  (Supplement C82.4AD1988) Ballasts for High Intensity Discharge and low Pressure Sodium Lamps (Multiple Supply Type).
C82.5  High Intensity Discharge Lamp Reference Ballasts.
C136.3  Roadway Lighting Equipment - Luminare Attachments.
C136.21 Roadway Lighting Equipment - Vertical Tenons Used with Post Top Mounted Luminaries.

E. California Codes

California Electrical Code.

California Code of Regulations, Title 24.

San Diego Municipal Code, Division 13, Light Pollution Law.

1.03 SUBMITTALS

A. Shop drawings including, photometric data to show that fixtures are of the same type, construction and quality as those indicated and specified. Provide dimensions, accessories, installation, and construction details. Include submittals on:

1. Lighting Fixtures.
2. Lamps.
4. Exit lighting Equipment.
5. Emergency Lighting Equipment.
6. Pole: Include dimensions, wind load (determined in accordance with AASHTO LTS2), pole deflection, pole class, and related technical information. Include pole foundation requirements with details showing dimensions, reinforcement bar requirements and foundation material.

B. Copies of lighting submittals as part of the project Operation and Maintenance manuals.

C. List of all tools, special tools, and spare parts required for erection, operation, maintenance, and adjustment.

D. Lighting fixture spare parts as follows:

1. One spare emergency head of each type for each lamp socket for every two or less installed;
2. One ballast for each type fixture installed;
3. One lamp of each wattage for each type fixture installed.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Lighting equipment manufacturers are as indicated on the fixture schedule.

2.02 LAMPS

A. Provide fluorescent fixtures with high output (800-MA Rapid Start) lamps of types and wattage indicated in lighting fixture schedules.

B. Provide: rapid start, high output, 48 inches long, 4250 lumen, 12,000 hour, 60 watt fluorescent lamps, for operation in ambient temperature above 40 degrees F.

C. Provide all lamps from one manufacturer. Provide lamps as manufactured by Sylvania Electric Products, Inc.; General Electric Co.; Philips Lighting Corp.; or approved equal.
2.03 BALLASTS

A. Fluorescent Fixtures

1. Provide high power factor, high power factor ballasts for 120 volt operation. Provide minus 20 degrees F, low temperature type ballasts. Ballasts are required to operate two lamps. Provide ballasts with an average input wattage of 145 watts or less when operating two F48T12, high output lamps. Ballasts shall be Class P protected with a minimum "A" sound rating.

2. Provide ballasts with Certified Ballast manufacturer label.

B. High Pressure Sodium Fixtures

1. Provide high power factor, high reactance ballasts for 35 watt lamps.

2. Provide high-pressure sodium ballasts suitable for 120 volt operation. Ballasts shall be indoor-outdoor type, single lamp. At any lamp voltage, from nominal through life, lamp wattage regulation spread at that lamp voltage shall not exceed 5 percent for plus or minus 10 percent line voltage variation. Power factor shall be a minimum of 90 percent.

C. Low Pressure Sodium Fixtures

1. Provide low pressure sodium ballast suitable for 120 operation. Ballasts shall be outdoor type single lamp.

D. Metal Halide

1. High power factor, normal ambient, 180 degrees C insulation class.

2. Type:
   a. Autotransformer with capacitor and igniter for lamps 150 watts and less.
   b. Constant wattage autotransformer with capacitor for lamps above 150 watts.

2.04 FIXTURES

A. Fluorescent Fixtures

1. Provide fluorescent fixtures with wraparound diffusers for all locations except where water spray is possible then use sealed diffuser covers.

2. Provide Lithonia model DMW-2-40-120, or equal.

B. Low/High Pressure Sodium Fixtures

1. Provide fixtures with die-cast aluminum housing, aluminum reflector, and polycarbonate lens. Provide fixtures with integral photocell control.

2. Provide Lithonia type TWP fixtures, or equal, in wattages as specified on Plans.
C. Incandescent Fixtures
   1. Provide fixtures designed for rough service, suitable for the service conditions anticipated at the locations specified on the Plans.

D. Provide only lighting fixtures listed and labeled by UL for the service conditions anticipated at the locations specified on the plans.

2.05 EXIT SIGNS

A. Provide tritium filled self-luminous exit signs with a useful life of ten years or longer. Provide Isolite model 2040-1 with ten-year life, or equal.

2.06 EMERGENCY LIGHTING EQUIPMENT

A. Provide fixture and two heads as indicated in fixture schedule. Provide emergency lighting units rated for 12 output volts. Provide units with brownout sensitive circuit to activate battery when AC input falls to 75 percent of normal voltage.

PART 3 - EXECUTION

3.01 INSTALLATION OF LIGHTING FIXTURES AND LAMPS

A. The Plans indicate the general location and arrangement of fixtures desired. Align fixtures in rows both vertically and horizontally. Install fixtures clear of pipes, mechanical equipment, structural openings, indicated future equipment, and other obstructions.

B. Suspend pendant fixtures by means of outlet box with cover-type aligners, each having flexible joint permitting unit to hang plumb. Install stems of 1/2 inch galvanized steel conduits.

C. Install accessories such as straps, mounting plates, nipples, or brackets necessary for required installation. Mounting heights are measured to bottom of fixture for ceiling mounted fixtures and to center of fixture for wall mounted fixtures. Obtain approval of the exact mounting for lighting fixtures from the Engineer before installation.

D. Connect emergency light fixtures within an area to the same circuit supplying power to the normal light fixtures within that area. Connect emergency light fixtures to the circuit before the light switch for normal lighting.

E. Install lighting rated for exterior use in all structures at or below finished grade. In these applications mount all lighting fixtures on stainless steel or galvanized unistrut, secured to walls or ceilings with stainless-steel anchors. Ensure that the finished lighting system is waterproof.

3.02 LAMP REPLACEMENT

A. Remove lamps used during the building construction, 14 calendar days prior to completion of the work and replace with new lamps.

3.03 FIXTURE CLEAN UP

A. Leave all fixtures in a clean condition, free of dirt and defects, before acceptance by the Engineer.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes the furnishing, installing and testing of an uninterruptible power supply as indicated on the Plans and as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 16050 General Electrical Requirements
B. Section 16110 Raceways and Fittings
C. Section 16120 Wires and Cables
D. Section 16140 Wiring Devices
E. Section 16160 Cabinet and Consoles
F. Section 16450 Grounding
G. Section 16470 Panelboards

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. National Electric Code, Current Edition
B. UL Listed
C. CAN/CSA C22.2

1.04 SUBMITTALS

A. The manufacturer shall provide non-proprietary software, and operating instruction manuals with fully detailed procedures pertaining to the following: system specifications, electrical power considerations, step by step assembly and installation procedures, troubleshooting procedures, programming procedures, explanation of internal fault diagnostics, shut down procedures, recommended spare parts lists.

B. Warranty certification from manufacturer.

1.05 MANUFACTURERS

A. UPS greater than 3 KVA shall be Invensys Powerware, or approved equal.
B. UPS less than 3 KVA shall be Toshiba 1500 Series Type UE1A1A010C6, or approved equal

1.06 MANUFACTURERS SERVICES

A. The manufacturer shall have a network of trained and experienced field support personnel providing product application assistance, including initial system start up, selection of UPS hardware, software, communications and debugging through telephone consultation and on-site checkout. This support shall be available during the Water Authority’s normal working hours of Monday thru Friday, between 8:00 a.m. and 4:30 p.m.
B. The manufacturer shall instruct Water Authority personnel in the operation and maintenance of the UPS.

C. The manufacturer shall have a field service department staffed with experienced representatives with the capability of providing on site service.

1.07 QUALITY ASSURANCE

A. The UPS manufacturer shall have a minimum of ten years of recent and continuous product history in the uninterruptible power system industry manufacturing UPS’ that meet the requirement herein.

PART 2 – MATERIALS

2.01 GENERAL

A. Provide a true-online UPS to protect the Water Authority instrumentation, communications, and critical loads from line disturbances, subcycle power losses, and power outages. In normal operation, the AC power shall be rectified to DC power. The DC power from the charger shall maintain the batteries at full charge. At all times except by-bass failure mode, the inverter shall convert the battery DC power back to AC while it regulates and provides a sine wave power to the load. Provide the UPS complete with power indication, power outage audio alarm, inverter circuit breaker protection, power outage relay contacts, and low battery alarm relay contacts. Power fail contacts shall close on loss of power. Provide automatic by-pass on overload or UPS failure. Provide full system self test on power up.

B. The UPS shall be constructed of all new materials. No used or reconditioned equipment is acceptable.

C. The furnished electrical system shall be complete, undamaged and functional.

2.02 SYSTEMS LESS THAN 3 KVA

A. Input/Output Voltage: 120 volt AC, single phase, 60 HZ.

B. Minimum Output Rating: 1000 VA.

C. Output Harmonic Distortion: three percent maximum at full load.

D. Frequency Stability: plus or minus 0.5 percent.

E. Overload Capacity: 150 percent for 30 seconds.

F. Maximum Charge Rate with load: 20 amperes.

G. Internal Battery Ampere-Hour Rating: 7.0.

H. Internal Batteries: replaceable 12-volt sealed lead acid. Mount batteries in the UPS enclosure.

I. Maximum Recharge Time: four hours.

J. Minimum Battery Backup Time: seven minutes at full load.

2.03 SYSTEM GREATER THAN 3 KVA

A. Input/Output Voltage: 120-240 Volt single phase 60 HZ, or combination 208-240-480 volt three phase if field electrical service allows, as shown on the Plans.

B. Minimum Output rating: 3 KVA, or as designated on the plans.

C. Input Voltage Range: plus or minus 15 percent UPS remains on line and recharging.
D. Frequency Stability: plus or minus 0.5 percent.
F. Duration: Minimum battery backup time eight minutes full load, 24 minutes half-load (one string of batteries). Add strings as necessary to increase backup time per plan requirements.
G. Maximum recharge Time: four hours.
H. Operating Efficiency: 88 percent normal operation, 97 percent high performance power saver mode.
I. Enclosure Type: The UPS shall have maintenance, expandability, and modular capability to allow hot swap of battery modules and power controller modules. The cabinet shall have the required number of slots to accommodate such modules. The number of slots, three, six, nine, or twelve shall be shown on the Plans. The slots shall be populated with the required number of power controllers and battery modules to meet the site requirements.
J. Environmental: The UPS shall be the cabinet type. The cabinet shall provide enclosure type suitable for the job site environment, and provide protection for a damp and dusty environment as required.
K. Safety: Audible noise < 50 dBA. Provide zone four anchoring. Provide and maintain all safeguards necessary for the prevention of accidents and the safety of personnel. Conduct testing and checkout work in a safe manner.
L. Communications: Provide RS232 port and SNMP/WEB capability.
M. Batteries: Sealed leakproof and maintenance free, and mounted in the cabinet enclosure.
N. Maintenance bypass: Provide an external Make-Before-Break bypass switch with AC disconnect.
O. Overload Capability: 150 percent for ten seconds, 300 percent for twelve cycles.

2.04 WARRANTY
A. All equipment shall be warranted by the manufacturer to be free from defects in materials, workmanship, and performance, to meet all performance specifications, and to operate without malfunction resulting directly or indirectly from material or workmanship for a period of ten years from the date of installation.
B. The manufacturer shall offer a maintenance agreement providing service and repair after the initial two-year warranty period has expired. The maintenance agreement shall allow renewal on a yearly basis, unless a 30-calendar day notice of cancellation prior to anniversary date is received. The initial contract cost shall be determined on a per unit cost that will negotiated by the Water Authority and the manufacturer.
C. The manufacturer shall provide a written guaranty to the continuing availability of all hardware, or its equivalent replacement, that was purchased by the Water Authority. This guaranty shall extend for a period of five years, and shall include all power modules, battery modules, charger modules communication cards and chassis/back plane.

PART 3 - EXECUTION

3.01 INSTALLATION
A. Install securely where shown on the Plans, and at a height acceptable to the electric utility.
B. Install a critical loads distribution panel that is fed by the UPS.
3.02 GROUNDING

A. Grounding shall be in accordance with the NEC, ART. 250. At no point from the UPS disconnect through
the UPS to the critical load distribution panel shall the grounding conductor be bonded to the neutral
(grounded conductor).

END OF SECTION
PART 1 – GENERAL

1.01 DESCRIPTION
A. This section includes the procurement, installation, and testing of a cathodic protection system utilizing galvanic anodes.

1.02 RELATED WORK SPECIFIED ELSEWHERE
A. Section 02653 Steel Pipe
B. Section 03000 General Concrete Construction
C. Section 03480 Precast Concrete Vaults
D. Section 09900 Painting and Coating
E. Section 15000 Piping Schedule and General Piping Requirements

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS
A. American National Standards Institute
   C80.1 Rigid Steel Conduit, Zinc Coated.
B. American Society for Testing and Materials
   B3 Soft or Annealed Copper Wire.
   B8 Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   B418 Cast and Wrought Galvanic Zinc Anodes.
   B843 Magnesium Alloy Anodes for Cathodic Protection.
   C94 Ready Mix Concrete.
   D1248 Polyethylene Plastics, Molding and Extrusion Materials.
C. American Water Works Association Latest Revision
   C203 Coal-Tar Protective Coatings and Linings for Steel Water Pipelines.
   C205 Cement-Mortar Protective Lining and Coating for Steel Water Pipe.
   C214 Tape Coating Systems for the Exterior of Steel Water Pipelines.
   C217 Application and Handling of Wax-Type Protective Coatings and Wrapper Systems for Underground Pipelines.
1.04 GENERAL REQUIREMENTS

A. The Plans indicate the general arrangement of the cathodic protection facilities to be constructed. Where no dimensions are indicated on the Plans, the locations of anodes, cathodic protection test stations, rectifiers, and conduits may be changed up to five feet without the approval of the Engineer to avoid interference with other utilities and unforeseen obstacles. Where specific dimensions are shown on the Plans, or where proposed changes are greater than five feet, written approval by the Engineer is required. Where applicable, materials and equipment shall bear evidence of UL approval and conform to the requirements of all applicable federal, state and local laws, codes, and regulations.

1.05 SUBMITTALS

A. Qualifications of the Contractor’s Corrosion Engineer and Corrosion Technician.

B. Proposed alternate anode installation methods, proposed alternate testing methods, proposed alternate cathodic protection system startup procedure.

C. Certification by the Contractor’s Corrosion Engineer stating that the corrosion protection criteria in these specifications have been met.

D. Manufacturer's information for each item listed below. Include sufficient information to show that the materials meet the requirements provided herein, including references to specific sections and details shown on the Plans.

1. Magnesium Anodes
2. Pipe Lead And Bond Wire
3. Connectors
4. CP Test Stations
5. Below Grade CP Test Boxes
6. Reference Electrodes
7. Pipe Flange Insulating Kit
8. Polarization Cell
9. Monolithic Insulating Joints
10. Coating For Buried Insulated Pipe Flanges And Uncoated Pipe Specials
11. Plastic Warning Tape
12. Alumino-Thermic Weld Kits
13. Weld Coating

1.06 QUALITY ASSURANCE

A. The criteria used to indicate adequate corrosion protection of the steel pipeline shall be in accordance with NACE Standard RP0169.

B. The installation of the cathodic protection system’s electrical components shall conform to the National Electrical Code, applicable local codes, and the Recommended Practices of NACE Standard RP0169.

C. Provide all materials, equipment, labor, and supervision necessary for the completion of all installations and testing.

D. Obtain the services of a Corrosion Engineer to inspect and test the installation of the cathodic protection system. The Corrosion Engineer shall be a registered professional engineer with certification or licensing that includes education and experience in cathodic protection of buried or submerged metal structures, or a person accredited or certified by the National Association of Corrosion Engineers at the level of Corrosion Specialist or Cathodic Protection Specialist (i.e. NACE CP Level 4). Such a person shall have not less than five years experience inspecting pipeline cathodic protection systems.

E. Obtain the services of a Cathodic Protection Technician to inspect and test the installation of the cathodic protection system. The Cathodic Protection Technician refers to a person accredited or certified by the National Association of Corrosion Engineers at the level of Cathodic Protection Technician (i.e. NACE CP Level 2). Such a person shall have not less than five years experience inspecting pipeline cathodic protection systems.

F. Maintain record drawings for the cathodic protection system throughout the installation of the equipment. Properly identify all items of equipment and material. Show the exact locations of all rectifiers, anodes, buried wires, CP test boxes, and insulated pipe flanges using dimensional ties to existing structures or survey monuments.
PART 2 – MATERIALS

2.01 GENERAL

A. Provide cathodic protection system materials and equipment that are new, undamaged, and in the original packaging marked with the manufacturer’s name or trademark. The materials and equipment shall be of the manufacturer’s latest standard design and shall be fully compatible to provide a complete and functional cathodic protection system.

2.02 MAGNESIUM ANODES

A. High Potential Magnesium Anode Alloy: Anodes shall be cast magnesium alloy ingots conforming to ASTM B843 as manufactured by the Dow Chemical Company, Federated Metals Company, Magnesium Corporation of America, or equal. The Open Circuit voltage of this alloy should be minimum 1.70 volt with respect to a copper sulfate reference electrode. The high potential magnesium alloy chemical composition shall be as shown below:

<table>
<thead>
<tr>
<th>Component</th>
<th>Composition by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>0.01 percent maximum</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.5 percent to 1.3 percent</td>
</tr>
<tr>
<td>Copper</td>
<td>0.02 percent maximum</td>
</tr>
<tr>
<td>Silicon</td>
<td>0.05 percent maximum</td>
</tr>
<tr>
<td>Nickel</td>
<td>0.03 percent maximum</td>
</tr>
<tr>
<td>Iron</td>
<td>0.001 percent maximum</td>
</tr>
<tr>
<td>Others, each</td>
<td>0.05 percent max. each</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Remainder</td>
</tr>
</tbody>
</table>

B. Standard Potential Magnesium Anode Alloy: Anodes shall be cast magnesium alloy ingots conforming to ASTM B80, Alloy AZ63, Grade B, as manufactured by the Dow Chemical Company, Federated Metals Company, Magnesium Corporation of America, or equal. The Open Circuit voltage of this alloy should be minimum 1.50 volt with respect to a copper sulfate reference electrode. The standard potential magnesium alloy chemical composition shall be as shown below:

<table>
<thead>
<tr>
<th>Component</th>
<th>Composition by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>5.3 percent to 6.7 percent</td>
</tr>
<tr>
<td>Zinc</td>
<td>2.5 percent to 3.5 percent</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.15 percent minimum</td>
</tr>
<tr>
<td>Silicon</td>
<td>0.20 percent maximum</td>
</tr>
<tr>
<td>Copper</td>
<td>0.05 percent maximum</td>
</tr>
<tr>
<td>Nickel</td>
<td>0.003 percent maximum</td>
</tr>
<tr>
<td>Iron</td>
<td>0.003 percent maximum</td>
</tr>
<tr>
<td>Others, total</td>
<td>0.20 percent maximum</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Remainder</td>
</tr>
</tbody>
</table>

C. Special Backfill Cloth Bag: Each magnesium anode shall be prepackaged in a permeable cloth bag and backfill. The backfill grains shall be such that 100 percent is capable of passing through a 100 mesh screen. The backfill shall be firmly packed around the anode by mechanical vibration to a density that
will maintain the magnesium ingot in the center of the bag surrounded on average by at least one inch of backfill. The backfill shall have the following composition:

<table>
<thead>
<tr>
<th>Material</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gypsum</td>
<td>75 percent</td>
</tr>
<tr>
<td>Powdered Bentonite</td>
<td>20 percent</td>
</tr>
<tr>
<td>Anhydrous Sodium Sulfate</td>
<td>5 percent</td>
</tr>
</tbody>
</table>

D. Anode Core: The anode shall be cast with a galvanized steel wire or strip core and shall be recessed at one end so that the core is accessible for the lead wire connection.

E. Anode Lead Wire Connections: The lead wire shall be connected to the anode core with silver solder. The connection shall be mechanically secure before soldering and shall have at least 1-1/2 turns of wire at the connection. The connection shall be insulated by filling the remainder of the recess with electrical potting compound. Unless otherwise shown on the Plans, the anode lead wire shall be No. 8 AWG stranded copper wire with black HMW-PE insulation. The anode wire shall be long enough to extend to the anode test box without any splices and provide for a minimum of 24 inches of slack within the test box.

F. Magnesium anode weight, alloy, total anode bag weight, and dimensions shall be as shown on the Plans.

2.03 PIPE LEAD AND BOND WIRE

A. Use stranded copper wire. Wires with cut or damaged insulation are not acceptable and replacement of the entire lead will be required. Wires shall be sufficient length to extend from the point of installation on the pipeline to the appropriate corrosion monitoring test box without splices and provide for a minimum of 24 inches of slack within the test box.

B. Direct Buried CP Wires: Wires shall be stranded copper that conform to ASTM B3 and ASTM B8. All test wires shall be minimum No. 8 AWG. For identification purposes, larger gauge wires shall be used where test wires from two or more buried structures terminate in the same test box. Test wires shall have a 7/64 inch thick HMW-PE insulation specifically designed for cathodic protection service and suitable for direct burial in corrosive soil, conforming to ASTM D1248, Type I, Grade J3, Class C, Category 5 (HMW-PE Type CP).

C. CP Wires in Conduit: Wires shall be stranded copper that conform to ASTM B3 and ASTM B8. All test wires shall be minimum No. 8 AWG. For identification purposes, larger gauge wires shall be used where test wires from two or more buried structures terminate in the same test box. Test wires shall have THWN wire insulation that conforms to UL83. Wire insulation color shall be as shown in the Plans.

D. Pipe Joint Bonding Wire: Wire shall be No. 2 AWG and shall have 7/64 inch thick HMW-PE insulation specifically designed for cathodic protection service and suitable for direct burial in corrosive soil, conforming to ASTM D1248, Type I, Grade J3, Class C, Category 5 (HMW-PE Type CP). Install bond wires at the minimum length required.

2.04 CONNECTORS

A. Split bolts shall be compact, high strength, high conductivity copper alloy, have free-running threads and easy to grip wrench flats. All current carrying bolts and hardware shall be copper alloy.

B. Cable connection lugs for rectifiers, anode junction boxes, and CP test stations shall be constructed from high conductivity high strength copper alloy such as Ilsco Type SLU, Ilsco Type CP, or equal. Cable connection lugs shall not have any aluminum or steel subcomponents. All current carrying bolts and hardware shall be copper alloy.
2.05 CP TEST STATIONS

A. Junction boxes for above grade cathodic protection test stations installations shall be UL listed enclosures, and have dimensional and electrical stability over the environmental range it will be exposed. Junction boxes shall not rust, corrode, shatter, peel or absorb water. Cabinet shall have a stainless steel lockable quick release hasp and stainless steel hinged and rain-tight cover. Test stations shall have dimensional and electrical stability from minus 20 degree F to plus 175 degree F and be stable under ultraviolet exposure. Junction boxes shall be the Stahlin fiberglass JxxxxHPL series, the Hoffman stainless steel Type 304 or 316 A-xxxxCHNFSS series, or equal.

B. Each CP Test Station or CP Junction Box shall include a cross-laminated phenolic terminal board with a minimum thickness of 1/4 inch. The terminal board shall contain individual lugs for each wire entering the test station or junction box.

C. Anode Junction Box Shunts: The shunt resistance shall be such that a five Amp current causes a voltage drop of 50 millivolts (i.e. 0.010 ohms). Shunts shall be the 1/2 inch wide by 3 3/4 inch long flat manganin ribbon style such as the Agra J. B. shunt or the Holloway Type SW.

D. Wire and cable identification markers. Provide a durable wire identification tag for each cable. Acceptable tags are one inch diameter by 1/16 inch thick die stamped brass or stainless steel tags. Secure the tags to each cable with a heavy duty nylon wire tie, twisted bare No. 12 copper wire, or equal fastener. Die stamp the tags per the job specific identification legend on the Plans.

2.06 BELOW GRADE CP TEST BOXES

A. Provide an electrical pull box or concrete valve box for all below grade CP Test Stations. Generally, boxes shall be installed outside of any roads or parking lots. Where traffic loading of the boxes is required, they shall be designed to withstand H-20 traffic loads. Boxes shall be a minimum of 10-3/8 inches inside diameter, 12 inches deep, and have a cast iron cover. Covers for test stations shall have the words "SDCWA CP TEST" cast or welded thereon. Letters shall be minimum 3/4 inches tall and 1/4 inch raised from the surrounding flat area. Use Christy Concrete Products, G5, or equal.

2.07 REFERENCE ELECTRODES

A. Reference electrodes shall be the copper-copper-sulfate type, suitable for direct burial and designed to remain stable for at least 20 years.

B. The reference electrode shall have a minimum sensing surface area of eight square inches. It shall be capable of maintaining a stable potential within plus or minus ten millivolts to that of another new reference electrode while a three microampere electrical current is applied.

C. Reference electrode shall contain a barrier to inhibit migration of chloride ions from the soil into the reference electrode.

D. Reference electrode lead wire shall be No. 14 AWG, stranded copper, with RHH-RHW yellow colored insulation and shall be silver soldered to the copper core of the reference electrode with the connection epoxy sealed by the manufacturer.

E. Use Stelth 2 Model SRE-007-CUY by Borin Manufacturing, or Staperm Model CU-1-UGPC by GMC Corrosion, or equal.
2.08 PIPE FLANGE INSULATING KIT

A. For purposes of this specification, the terms “Pipe Flange Insulating Kit”, “Insulated Flange”, “Insulated Joint”, and “Dielectric Flange” are used synonymously.

B. Pipe flange insulating kit materials shall be designated by the manufacturer as suitable for service at the operating temperatures and pressures specified on the Plans.

C. Flange insulating kits shall consist of a one piece, full-face, insulating gasket, an insulating sleeve for each bolt, insulating washers, and steel washers. For nominal pipe diameters up to and including 36 inches, provide one insulating washer and one steel washer on each side of the flange. For nominal pipe diameters greater than 36 inches, the insulating washers shall be installed sandwiched between a pair of matching steel washers on each side of the flange.

D. Insulating Gasket: Insulating gasket retainers shall be full face, Type E, NEMA G10 epoxy glass retainers with a nitrile (Buna-N) rectangular cross section O-ring seal. Minimum total gasket thickness shall not be less than 1/8 inch. The gasket shall have the same outside diameter as the pipe flange. For cement mortar lined pipe, the gasket’s inside diameter shall be one inch greater than the nominal pipe diameter. For epoxy lined pipe, the gasket’s inside diameter shall be equal to the nominal pipe diameter. Dielectric strength shall be not less than 550 volts per mil, and compressive strength shall be not less than 50,000 psi. The manufacturer’s name and date of manufacture shall be marked on both sides of the gasket with two inch tall letters. The gasket shall be installed within six months of the date of manufacture. Use PSI Linebacker insulating gasket, or equal.

E. Insulating Sleeves: Provide full length, one piece, NEMA G10 epoxy glass insulating flange bolt sleeves. Dielectric strength shall be not less than 400 volts per mil. The length of the insulating sleeves shall provide an air gap between the end of the insulating sleeve and inside surface of the stud bolt nut with a tolerance of 1/32 inch minimum and 1/8 inch maximum.

F. Insulating Washers: Insulating washers shall be NEMA G-10 epoxy glass with a minimum thickness of 1/8 inch. Dielectric strength shall not be less than 550 volts per mil, and compressive strength shall not be less than 50,000 psi. The insulating washer’s inside diameter shall be sized to fit over the insulating sleeve’s outside diameter.

G. Provide minimum 1/8 inch thick steel washers for placement over the insulating washers. The inside and outside diameter of the steel washers shall match those of the insulating washers. The steel washers must be able to freely rotate around the insulating sleeve. Attention must be paid to the fit between the steel washers and the insulating sleeve in order to avoid the washers twisting the sleeves when the flange bolts are torqued.

H. Provide four extra insulating sleeves and eight extra insulating washers for each insulating flange upon successful inspection of the insulating flange.

2.09 POLARIZATION CELL

A. Type and Rating: Solid-state device designed to provide direct current electrical isolation and simultaneous alternating current electrical grounding. Ratings are to be as follows:

1. 60 Hz Current (short duration, three cycles): 5,000 amperes AC root mean square symmetrical.

2. 60 Hz Current (steady-state, 65 degree C ambient): 40 amperes AC RMS symmetrical.

3. Lightning Surge Current: 100,000 amperes.

4. DC Current Leakage (driving voltage 1VDC, 65 degree C): Less than 0.1 milliampere.
5. Ambient Operating Temperature: Minus 40 degree F to plus 150 degree F.


7. Manufacturer and Product: Dairyland Electrical Industries, Model PCR-3.7KA, or equal.

B. Bus Bars and Mounting Hardware: All components required for mounting provided by polarization cell manufacturer, as shown on the Plans. Bus bar for mounting polarization cell to pipe flanges shall be copper conforming to ASTM B 124, Alloy C110.

2.10 MONOLITHIC INSULATING JOINTS

A. The Monolithic Insulating Joints shall be installed in the piping system at the locations shown on the Plans. MJJs shall be boltless, factory assembled, and welded into the piping section.

B. The insulating component shall be as recommended by the MJJ manufacturer and as in writing by the Engineer. The steel components of the MJJ shall match the pipe section to which it is attached.

C. Each pipe section with an MJJ shall be hydrostatic tested to 1-1/2 times the rated operating pressure. Testing shall be conducted between testing plates or end caps to ensure the most arduous conditions and shall be witnessed by the Engineer.

D. The manufacturer shall inspect all welds used to construct the MJJ with ultrasonic, magnetic particle, and dye penetrant tests. The manufacturer shall test each MJJ for electrical isolation after the completion of hydrostatic tests. Testing shall be witnessed by the Engineer. Electrical resistance shall be a minimum of five Megohms. Written test results shall be submitted to the Engineer.

E. Each MJJ shall be provided with a lining material that matches the type and thickness of the lining material of the pipe to which it is attached.

F. Each MJJ shall be externally coated with a two part epoxy coating applied to a minimum dry film thickness of 0.010 inches to within two inches of each end. Each pipe section with a MJJ shall be coated with one inch thick cement mortar conforming to Section 09871. The steel reinforcement in the cement mortar coating shall be held back two inches from both sides of the MJJ’s insulating ring so as to avoid creating a metallic path across the insulated gap.

G. Electrical isolation tests shall be repeated by the Engineer at the job site when the MJJ is delivered, before the MJJ is attached to the pipeline, and before any field applied linings or coatings are applied to it. MJJ electrical resistance shall be a minimum of 5 Megohms.

H. The MJJ shall be one of the following trademark/trade name products: Iso-Joint, Iso-Bloc, Electro-Stop, or equal.

2.11 COATING FOR BURIED INSULATED PIPE FLANGES AND UNCOATED PIPE SPECIALS

A. Apply a wax tape coating system which conforms to AWWA C217 and consists of three parts: surface primer, wax-tape, and outer covering.

B. The primer shall be a blend of petrolatum, plasticizer, and corrosion inhibitors having a paste like consistency. It shall have a pour point of 100 degree F to 110 degree F and a flash point of 350 degree F. Use Trenton Wax-Tape Primer, or equal.

C. The wax-tape shall consist of a synthetic-fiber felt, saturated with a blend of high melt microcrystalline wax, solvents, and corrosion inhibitors, forming a tape coating that is easily formable over irregular surfaces and which firms up after application. The tape shall have a saturant pour point between 125
degree F and 130 degree F and a dielectric strength equal to a minimum of 100 volts per mil. Tape thickness shall be 70 mils to 90 mils in six inch wide rolls. Use Trenton No. 1 wax-tape, or equal.

D. The outer covering shall consist of two layers of a plastic wrapper. The plastic wrapper material shall consist of three 10-mil thick clear polyvinylidene chloride, high cling membranes wound together as a single sheet. Use Trenton Poly-Ply, or equal.

2.12 PLASTIC WARNING TAPE

A. Plastic warning tape for horizontal runs of buried leads in cable trenches shall be a minimum of four mils thick and six inches wide, inert yellow plastic film designed for prolonged use underground. The tape shall have the words, "CAUTION CATHODIC PROTECTION CABLE BELOW," or similar, clearly visible in repeating patterns along its entire length.

2.13 ALUMINO-THERMIC WELD KITS

A. Exothermic weld material shall be a mixture of copper oxide and aluminum, packaged by size in plastic tubes as shown in the Plans. The materials shall be non-explosive and not subject to spontaneous ignition.

B. Exothermic weld material and accessories shall be Erico Products, Inc., ThermOweld® or equal. Materials from different manufacturers shall not be mixed.

2.14 WELD COATING

A. Coating for all welds shall be a cold-applied, fast drying mastic consisting of bituminous resin and solvents. The minimum percentage of solids shall be 80 percent.

2.15 CONCRETE

A. Concrete used for rectifier and cathodic protection test station installations shall be Class B per Section 03000.

B. Concrete used for CP conduit trenches shall be Class D per Section 03000. The concrete shall be mixed with two lbs of red dye per 100 lbs of cement.

PART 3 – EXECUTION

3.01 INSTALLATION OF GALVANIC ANODES

A. Install galvanic anodes at the locations shown in the Plans.

B. If a minimum anode hole diameter is indicated on the Plans, it is only applicable to drilled anode holes. The anode holes may be drilled with auger equipment, rotary bit/drilling mud equipment, or the anodes may be installed by conventionally excavated deep trenches at the option of the contractor. Unless otherwise noted in the Plans, vertical galvanic anodes (in drilled holes) may also be installed horizontally (in deep trenches). If installed horizontally, the depth of the horizontal anodes shall be equal to the lower depth of the vertical anode specification.

C. Anodes shall not be dropped in the hole or lowered by the copper wire. A separate non-metallic support line shall be used to lower the anodes. The support line can be abandoned in place for each anode hole or retrieved with the use of a release line.

D. After lowering the prepackaged anode into the anode hole, add a minimum of 30 gallons of potable water to the hole to fully saturate the powdered backfill (bentonite/gypsum/sodium sulfate) mixture around the
anode. Allow a minimum of 30 minutes for the water to soak into the anode backfill mixture before backfilling the hole.

E. Backfill the anode hole with native soil in layers not exceeding six inches deep. Tamp each layer to remove voids.

F. Trench all anode wires in SCH 40 PVC electrical conduit to the Anode Junction Box as shown on the Plans.

3.02 INSTALLATION OF REFERENCE ELECTRODE

A. Measure the accuracy of each copper/copper sulfate reference electrode before installation by measuring the direct current voltage difference between it and one or more reference electrodes of known accuracy. The measurements shall be less than plus or minus 0.010 DC Volts for all reference electrodes. Perform these measurements after totally submerging the reference electrodes in a five gallon bucket of potable water for a minimum period of 15 minutes. Brackish water or saltwater will not be allowed. Provide five days written notice to the Engineer to allow these tests to be witnessed.

B. Install the copper/copper sulfate reference electrodes as shown on the Plans. Provide a minimum 24 inches of slack wire around the reference electrode to allow for movement during backfill and soil compaction. Exercise care so as not to damage or pierce the insulation of the reference electrode lead wire. Cover the reference electrode with six inches of native rock free soil and saturate it with a minimum five gallons of potable drinking water. Backfill as shown in the Plans.

3.03 CATHODIC TEST STATION

A. For purposes of this specification, the terms “Cathodic Test Station”, “Cathodic Protection Test Station”, “Cathodic Test Box, and “CP Test Box” are used synonymously to refer to a group of test wires welded to a pipeline, casing, or tunnel which are trenched to an electrical junction box, flush mounted valve box, or flush mounted meter box.

B. Construct Cathodic Test Stations to enable periodic cathodic protection system monitoring. Unless otherwise shown on the Plans, provide CTS at the following locations:

1. Pipe Crossing CTS - Provide four-wire CTS at all locations where Water Authority cathodically protected pipelines cross other cathodically protected pipelines to enable testing the electrical interaction between the two pipelines. Provide a pair of test wires welded to each pipeline.

2. Casing Isolation CTS - Provide Casing Isolation CTS at all locations where Water Authority cathodically protected pipelines run inside steel casings or steel reinforced tunnels to enable testing the integrity of electrical isolation between the pipeline and casing. Provide a pair of test wires welded to the pipeline and to the casing or tunnel.

3. Insulated Flange CTS - Provide Insulated Flange CTS for all insulated flanges. Where insulated flanges are located inside vaults, flow control facilities, and pump stations, mount the test boxes on the exterior walls of these structures to enable cathodic protection monitoring without entering the structure. Where multiple insulating flanges are connected in electrical parallel configurations, only one Insulated Flange CTS is required for each group. Provide a pair of test wires welded to the pipe on each side of the insulated flange, total four wires required. For buried insulated flanges only, provide an additional pair of pipe test wires attached to the pipe a distance of 250 feet away (plus or minus 20 feet to the nearest pipe joint) from the insulated flange, total six wires required. Provide the additional pair of pipe test wires on the side of the insulated flange which will be cathodically protected. Use unique wire sizes or wire colors to distinguish the different pipe attachment locations.
4. Galvanic Anode Junction Boxes - Provide Anode Junction Boxes for all galvanic anode installations. Do not direct connect anodes to the pipelines. Provide an individual shunt for each anode wire to enable monitoring of individual anodes.

C. All pipelines to be monitored with a CTS shall have a minimum of two test wires welded to it.

D. Wherever possible, mount CTS boxes to the exterior walls of vaults and other structures.

E. Where flush mounted CTS are specified for a pipeline in a paved street, install the CTS boxes in areas away from traffic hazards, such as in medians or behind curbs.

F. Where flush mounted CTS are specified provide a minimum of 24 inches of slack in all test wires to enable them to be removed from the box during periodic CP system testing.

G. Where flush mounted CTS are specified for pipelines in unpaved areas place a single four inch diameter steel pipe marker post to denote the location of each test station. The marker post shall be seven feet long with the lower three feet below ground in a 16 inch diameter by 42 inch deep 3,000 psi concrete footing. Paint the marker post with safety yellow epoxy paint. Provide four bands of white reflective safety tape at the top of the marker post. Below the reflective tape, paint the letters “CPTS” and the pipeline station number using black high gloss epoxy paint.

3.04 WIRE-TO-PIPE CONNECTIONS ON BURIED PIPE

A. Exothermically weld the CP test wires to pipelines at the nearest pipe joint to the pipeline station indicated on the Plans.

B. Install the cables with sufficient slack so that the cable insulation and conductors will not be damaged during the pipe backfilling process. Protect the cables by running them in schedule 40 PVC electrical conduit. Begin the PVC conduit within three feet of the welded connection to the pipe.

C. For dielectrically coated steel pipelines, cover the exothermically welded connection with a polyethylene weld cap. Seal all around the weld cap and any other areas of exposed steel with a bitumastic coating or a two part high build fast cure epoxy coating.

D. For cement mortar and concrete coated pipelines, cover the exothermic weld nugget and all disturbed areas of the pipeline coating with a quick cure, non-shrink, cementitious, patching compound. Apply the compound to a thickness of one inch or to match the surrounding pipe coating thickness, whichever is greater. The patching compound shall have a set time of 20 minutes, a maximum shrinkage of 0.087 percent after seven days (ASTM C 596 test method), achieve a minimum compressive strength of 3,570 psi in one day, and a minimum compressive strength of 8000 psi in 28 days (ASTM C109). Use “Jet Set Complete Repair” as manufactured by Jet Set Cement Corporation or equal.

3.05 WIRE-TO-PIPE CONNECTIONS ON EXPOSED PIPE

A. For wire-to-pipe connections inside vaults and other structures, exothermically weld the CP test wires to the pipe within one foot of the pipe-wall penetration, on the interior side. The welded connections shall be positioned so that the wires do not interfere with the installation or removal of flange bolts.

B. Paint the exothermically welded connection with a coating that matches material and color of the surrounding pipe coating.

3.06 EXOTHERMIC WELDS

A. Make wire connections to the pipeline or other structure with an exothermic weld process ("Cadweld", "ThermOweld", or equal) per manufacturer’s recommendations.
B. Provide a minimum separation of six inches between multiple exothermic welds.

C. Remove a minimum amount of the existing coating required for placement of the weld mold on the steel structure. The steel surface must be completely clean and dry (near white metal surface preparation).

D. Test the weld integrity by striking it from the side with a two pound hammer. If the weld comes off, move away a minimum of three inches and repeat steps A through D.

E. After testing, apply weld coating.

3.07 PIPE JOINT BONDING WIRES

A. During installation of the pipe, electrically bond across all buried pipe joints which are not circumferentially welded as shown in the Plans. Install bond wires across buried or submerged metallic in-line valves, flex couplings, bolted flanges, and fittings, except for insulated pipe flanges and monolithic insulating joints. Install bond wires using the minimum length required. For pipeline diameters less than 72 inches, a minimum of two No. 2 AWG copper bond wires are required for each bonded joint. For pipeline diameters 72 inches and greater, a minimum of three No. 2 AWG copper bond wires are required for each bonded joint.

B. Do not install bond wires across pipe joints or pipe flanges inside valve vaults and other structures unless specifically shown on the Plans.

3.08 INSTALLATION OF INSULATING FLANGE MATERIALS

A. Install pipe flange insulating materials at the locations shown on the Plans. Install pipe flange insulating materials in accordance with the manufacturer's recommendations and NACE recommended practice RP0286, "Electrical Isolation of Cathodically Protected Pipelines." Particular attention shall be paid to properly aligning the flanges prior to inserting the insulating sleeves around flange bolts. Prevent moisture, soil, or other foreign matter from contacting any portion of the insulating joint prior to or during installation. If moisture, soil, or other foreign matter contacts any portion of the insulating joint, disassemble the entire joint, clean with a suitable solvent and dry prior to reassembling. Follow the manufacturer's recommendations regarding the torquing pattern of the bolts and the amount of torque to be used when installing the flange insulating kit. As required, use only non-conductive lubricants such as Huskey 2000 Lubricating Paste & Anti-Seize compound, 3M Super 77 Spray Adhesive, and Triflow aerosol lubricant with Teflon additive, on the flange bolts or other flange components.

3.09 POLARIZATION CELL

A. Install polarization cells at insulating flanges as shown on the Plans.

B. Mount polarization cell to pipe flanges using bus bars and bolted connections.

3.10 COATING OF BURIED INSULATED PIPE FLANGES

A. Coat buried insulated pipe flanges with a wax tape coating system in accordance with AWWA C217. The wax tape coating system shall extend over the adjacent pipe coating by a minimum 12 inches, or 18 inches away from the flange surface, whichever is greater.

B. The surfaces to receive the wax tape coating shall be clean and free of all dirt, grease, and other foreign material. Apply the primer by gloved hand or brush onto all exposed steel surfaces. Cut strips of wax tape and apply them by gloved hand around all bolts, nuts, and other irregular shapes so that there are no voids or spaces under the tape. Apply a sufficient amount of tape to completely encapsulate all exposed steel surfaces with a minimum wax tape thickness of 140 mils. Apply by hand two layers of...
polyvinylidene chloride, high cling membrane sheet over the wax tape coating by tightly wrapping it around the pipe such that it adheres and conforms to the wax tape. Secure the plastic wrap to the pipe with adhesive tape.

3.11 TESTING INSULATED PIPE FLANGES

A. The Contractor’s Cathodic Protection Specialist, Corrosion Engineer, or Corrosion Technician shall test the electrical isolation effectiveness of each insulated pipe flange. The Contractor shall provide written notice of this testing to the Engineer a minimum of two days in advance. If the insulated pipe flange will be buried, it shall be tested for electrical isolation by the Contractor before the wax tape coating is applied and before it is connected to the pipeline. At the Engineer’s option, the Water Authority may repeat this testing during or immediately after the installation of the insulating flange. Replace or repair any insulated pipe flange that is determined not to be electrically effective. The effectiveness of insulating flanges shall be determined using the following test techniques in the order shown until one of the criteria is achieved or as otherwise directed by the Engineer.

1. Electrical Potential Difference Test: Electrically bond the pipe on the vault or unburied side of the insulating flange to an electrical ground with a maximum resistance to remote soil of five Ohms. If the pipe on both sides of the insulating flange is mechanically connected to a minimum 50 feet of buried pipe, then the pipe does not need to be bonded to an electrical ground for this test. Measure the CP Potential of the pipe on both sides of the insulating flange using a copper/copper sulfate reference electrode. If the difference in CP Potentials is greater than or equal to 400 millivolts, the insulating flange is providing adequate electrical isolation. If this criterion is not met, perform the Nilsson 400 Meter Direct Resistance Test to verify the effectiveness of the insulating flange.

2. Direct Resistance Test: Measure the electrical resistance across the insulated flange using a 97 Hertz square wave null balancing ohmmeter such as the Model 400 Nilsson Soil Resistance Meter and the four-wire resistance technique. A standard handheld digital multi-test meter's ohmmeter circuit (e.g. Fluke 97 or Beckman HD110) is not suitable for properly making these resistance measurements. Perform this test by connecting the meter’s P1 and C1 terminals to one side of the insulating flange, using two wires, and then connecting the meter’s P2 and C2 terminals to the other side of the insulating flange, using two additional wires. Use vise grips or temporary exothermic welds to make the wire connections to the flange or pipe. The criterion for a pipe filled with water is a minimum measurement of five Ohms. The criterion for a dry or a partially filled pipe is a minimum measurement of 100 Ohms. If none of the applicable criteria are met, perform the Inductive Ammeter Direct Resistance Test to verify the effectiveness of the insulating flange.

3. Inductive Ammeter Direct Resistance Test: Connect two separate wires via two separate connections to the pipe on both sides of the insulating flange. Use vise grips or temporary exothermic welds to make the wire connections. Use two pairs of test wires, one for current flow, one for voltage measurement. Using the first set of test wires, apply a minimum 12 volt DC electrical current across the insulating flange. Using the second set of test wires, measure the voltage across the insulating flange developed by the DC current flow. Use a an inductive ammeter hoop (e.g. Swain hoop) clamped around the pipe immediately adjacent to the insulating flange to measure the change in DC current flow in the pipe, through the insulated flange. Calculate the electrical resistance across the insulating flange in Ohms by dividing the change in DC Volts by the change in DC Amps (i.e. Ohm’s Law). The criterion for a pipe filled with water is a minimum measurement of five Ohms. The criterion for a dry pipe is a minimum measurement of 100 Ohms. If either of the applicable criteria is not met, perform the NACE Insulating Flange Leakage Test, per NACE RP0286, to verify the effectiveness of the insulating flange.

4. NACE Insulating Flange Leakage Test: This test procedure shall conform to the "Leakage Test" described in the NACE Standard RP 0286, Section 8, "Field Testing and Maintenance", Figure 12. The test current used shall be between three and five DC Amps. The criterion for a pipe filled with
B. Individual Flange Bolt Electrical Resistance Testing: For all insulated flanges to be buried and for all other insulating flanges that do not meet any of the previous minimum criteria, measure the electrical resistance of each flange bolt to both sides of the insulated flange using a Nilsson Model 400 Soil Resistance Meter and four-wire resistance technique. The measured resistance value for each flange through-bolt shall be a minimum of 1,000 Ohms, as measured from each bolt to both flanges. This criterion applies to flange through-bolts and does not apply to valve cap bolts. If lower resistance values are measured, remove, inspect, and replace all imperfect dielectric flange bolt sleeves and washers. If an insulated flange with threaded cap bolts passes the resistance tests for all the “through-bolts” yet fails the other previous tests, remove all the threaded cap bolts, inspect and replace all imperfect dielectric flange bolt sleeve and washer materials and retest.

3.12 ELECTRICAL ISOLATION TESTING BETWEEN PIPE AND STEEL REINFORCEMENT

A. Conduct testing to demonstrate that steel reinforcement in concrete structures and pipe encasements is not in contact with buried steel pipe. Correct all contacts detected between pipe and reinforcement by removing the concrete as necessary and trimming or repositioning reinforcement to eliminate all points of contact.

B. The Contractor shall prepare written test procedures specifying the methods and equipment that will be used. Submit the proposed test method to the Engineer for approval a minimum of 30 days before the first concrete placement.

C. Isolation test methods may include measurements made between pipe and reinforcement for voltage difference, electrical resistance, or other parameters as required to prove electrical isolation. In no case shall an electrical resistance measurement made with a volt-ohm multimeter be accepted as a test procedure. In the event of a question regarding the electrical isolation of the pipe, the Engineer shall make the final determination.

D. Electrical isolation tests shall be conducted for each pipeline one day before placing concrete, the morning before concrete is placed, and immediately after the concrete is placed. The Engineer will witness the electrical isolation test conducted before the concrete is poured.

3.13 ELECTRICAL CONTINUITY TESTING OF PIPE WITH BONDED JOINTS

A. Conduct electrical continuity testing to demonstrate that all buried pipe joints (except insulated flanges) are either welded joints or have been electrically bonded across with No. 2 AWG stranded copper bond cables. The Contractor’s Cathodic Protection Technician shall conduct the tests. The Engineer will witness the electrical continuity tests. The Contractor shall demonstrate to the Engineer’s satisfaction that full electrical continuity has been achieved and shall make all required bond cable connections in the event that electrical continuity of the pipe is not achieved.

B. Perform electrical continuity tests at maximum spacings of 800 feet of pipe. Circulate a 12 volt electrical direct current through the pipeline. Use two pairs of test wires, one for current flow, one for voltage measurement. Measure the voltage difference developed by the DC current flow. Calculate the electrical resistance of the pipeline section in Ohms using Ohm's Law. The resistance test acceptance criterion is less than 150 percent of the calculated resistance value. The resistance value shall be calculated using the steel cross section area of the pipe, its length, and consideration for the joint bond cables at each bonded joint.

C. If other electrical continuity test methods are proposed, the Contractor shall prepare a written test procedure specifying the alternate method and equipment that will be used. A standard handheld digital multi-test meter's ohmmeter circuit (e.g. Fluke 87 or Beckman HD110) is not suitable for properly
making these measurements. Submit in writing the alternate proposed test method to the Engineer for approval a minimum of 30 days before the pipe laying begins.

3.14 CATHODIC TEST STATION TESTING

A. Testing of Completed Welds: Exothermic weld connections shall be inspected by the Engineer prior to backfilling. At the Engineer's direction, tests to verify the soundness of the welds shall be conducted by the Contractor. Tests for this purpose shall consist of striking the weld nugget with a two pound hammer while steadily pulling on the wire. Note that the wire near the weld shall not be unnecessarily cold worked during installation or testing. Remove and reweld any welds that break loose or show signs of separating, as determined by the Engineer.

B. Wire Identification: Provide the Engineer 48 hours advance notice to verify that buried pipe lead wires and anode lead wires are properly identified with die stamped brass or stainless steel tags prior to backfilling the wires and the welded wire-to-pipe connections.

C. Pipe Test Wire Integrity Tests: After the pipe is buried, the pipe lead wire trenches are backfilled, and the cathodic test boxes are installed, the Engineer shall test each set of pipe lead wires for electrical continuity to the pipe. If more than twice the theoretical resistance of the pipe lead wire lengths is measured, the Contractor shall excavate the pipe and replace the pipe lead wires.

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<td>0.262</td>
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3.15 CATHODIC PROTECTION SYSTEM ACTIVATION

A. Retain a NACE certified Level 2 Cathodic Protection Technician to perform the inspection testing. Perform tests under the direct supervision of a licensed professional Corrosion Engineer or a NACE certified Level 4 Cathodic Protection Specialist or NACE certified Corrosion Specialist. Supervision is defined in this specification as requiring a minimum eight hours of onsite field work at the start of the inspections to work with the Cathodic Protection Technician to plan, direct, and verify the testing procedures and to provide troubleshooting as required.

B. Provide a minimum of five days advance notice to the Engineer before the cathodic protection activation will be performed to allow for coordination and observance of these tests.

C. Before beginning each day of testing, calibrate portable copper sulfate reference electrodes with respect to a master reference copper sulfate reference electrode.

D. Measure CP Native Potentials (i.e. baseline pipe-to-soil potentials) at all Cathodic Test Stations prior to activating the cathodic protection system. Measure CP Native Potentials on both sides of all insulating flanges, monolithic insulators, dielectric unions, and at all CTS wires. Where two wires are attached to the same pipeline, measure and record the CP Native Potentials for both wires. If the potential measurements for the same pipeline differ by more than two millivolts, investigate the cause. See the previous paragraph titled “Pipe Test Wire Integrity Tests”.

General Conditions and Standard Specifications
E. At CTS constructed with buried copper/copper sulfate reference electrodes (i.e. stationary reference electrode”) measure CP Native Potentials of the pipeline using both the stationary reference electrode and a portable copper sulfate reference electrode before the CP system is activated.

F. Measure the CP Potentials of all galvanic anodes before they are connected to pipe wires at the CTS or Anode Junction Boxes. Verify minimum values of negative 1.50 volts for standard potential magnesium anodes and minimum negative 1.70 volts for high potential magnesium anodes. While making these measurements, place the copper sulfate reference electrode in the soil directly over the anode holes.

G. Activate the cathodic protection system by connecting all the anode wires to the shunts inside the anode junction boxes.

H. Measure CP “On Potentials” at the same locations where CP “Native Potentials” were previously measured.

I. Measure all anode currents at anode junction boxes by measuring the voltage drop across the calibrated shunts provided. Calculate the corresponding amount of direct current flow using the shunt rating. Explicitly state the shunt rating on each data sheet.

J. Remeasure CP “On Potentials” at all CTS at least two weeks after the initial energization of the cathodic protection system to allow for the development of the cathodic polarization process.

K. Furnish all test results including all CP Potential readings, anode current readings, insulating flange test data, dates, and times. Reference all data to pipeline station numbers. Submit all data along with a letter report to the Engineer. The letter report shall include a description of the test methods, analysis of the data, and conclusions about the CP system’s effectiveness. Submit all data in spreadsheet format compatible with Microsoft Excel. Submit data in both hard copy and computer disk format.

3.16 ACCEPTANCE CRITERION FOR STEEL PIPE WITH DIELECTRIC COATING

A. The operation of the cathodic protection system shall be tested to ensure that all portions of the pipeline are provided a full level of corrosion protection. The standard used to evaluate the CP potential measurements shall be in accordance with only the 0.85 Volt criterion in NACE RP0169.

1. 0.85 VOLT CP ON POTENTIAL - A negative voltage of at least 0.85 volt as measured between the pipeline and a copper sulfate reference electrode contacting the soil immediately over or adjacent to the pipeline. Determination of this voltage is to be made with the cathodic protection current applied. Voltage drops must be considered for valid interpretation of this voltage measurement. To avoid anode gradient voltage drop errors (i.e. IR drop error), this criterion shall only be used at locations greater than 20 feet away from any galvanic anodes and greater than 200 feet away from any impressed current anodes.

3.17 ACCEPTANCE CRITERIA FOR STEEL PIPE WITHOUT A DIELECTRIC COATING

A. The operation of the cathodic protection system shall be tested to ensure that all portions of the pipeline are provided a full level of corrosion protection. The standards used to evaluate the CP potential measurements shall be in accordance with either of the two following NACE RP0169 criteria.

1. 0.85 VOLT CP ON POTENTIAL - A negative voltage of at least 0.85 volt as measured between the pipeline and a copper sulfate reference electrode contacting the soil immediately over or adjacent to the pipeline. Determination of this voltage is to be made with the cathodic protection current applied. Voltage drops must be considered for valid interpretation of this voltage measurement. To avoid anode gradient voltage drop errors (i.e. IR drop error), this criterion shall only be used at locations greater than 20 feet away from any galvanic anodes and greater than 200 feet away from any impressed current anodes.
2. 100 mV CP POLARIZATION SHIFT - A minimum polarization shift of 100 millivolts measured between the pipeline being protected from corrosion and a copper sulfate reference electrode contacting the soil immediately over or next to the pipeline. This minimum polarization shift shall be determined by interrupting all cathodic protection currents and measuring the polarization formation or decay. At the instant the cathodic protection current is interrupted ("instant off"), an immediate voltage shift will occur. The voltage reading just after the immediate shift shall be used as the base reading from which to calculate the polarization formation or decay.

END OF SECTION
PART 1 – GENERAL

1.01 DESCRIPTION

A. This section includes the procurement, installation, and testing of a cathodic protection system utilizing an impressed current system(s).

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02653 Steel Pipe
B. Section 03000 General Concrete Construction
C. Section 03480 Precast Concrete Vaults
D. Section 09900 Painting and Coating
E. Section 15000 Piping Schedule and General Piping Requirements

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American National Standards Institute
   C80.1 Rigid Steel Conduit, Zinc Coated.
B. American Society for Testing and Materials
   A518 High Silicon Cast Iron Anodes.
   B3 Soft or Annealed Copper Wire.
   B8 Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   C94 Ready Mix Concrete.
   D1248 Polyethylene Plastics, Molding and Extrusion Materials.
C. American Water Works Association Latest Revision
   C203 Coal-Tar Protective Coatings and Linings for Steel Water Pipelines.
   C205 Cement-Mortar Protective Lining and Coating for Steel Water Pipe.
   C214 Tape Coating Systems for the Exterior of Steel Water Pipelines.
   C217 Application and Handling of Wax-Type Protective Coatings and Wrapper Systems for Underground Pipelines.
D. National Association of Corrosion Engineers
   RP0169 Control of External Corrosion on Underground or Submerged Metallic Piping Systems (Revised 2002).
1.04 GENERAL REQUIREMENTS

A. The Plans indicate the general arrangement of the cathodic protection facilities to be constructed. Where no dimensions are indicated on the Plans, the locations of anodes, cathodic protection test stations, rectifiers, and conduits may be changed up to five feet without the approval of the Engineer to avoid interference with other utilities and unforeseen obstacles. Where specific dimensions are shown on the Plans, or where proposed changes are greater than five feet, written approval by the Engineer is required. Where applicable, materials and equipment shall bear evidence of UL approval and conform to the requirements of all applicable federal, state and local laws, codes, and regulations.

1.05 SUBMITTALS

A. Qualifications of the Contractor’s Corrosion Engineer and Corrosion Technician.
B. Qualifications of the Contractor’s cathodic protection well driller meeting the experience requirements specified herein, including contract information for project references.

C. Proposed alternate anode installation methods, proposed alternate testing methods, proposed alternate cathodic protection system startup procedure.

D. Certification by the Contractor’s Corrosion Engineer stating that the corrosion protection criteria in these specifications have been met.

E. Manufacturer's information for each item listed below. Include sufficient information to show that the materials meet the requirements provided herein, including references to specific sections and details shown on the Plans.

1. Impressed Current Anodes
2. Cathodic Protection Rectifiers
3. Coke Backfill
4. Anode Vent Pipe
5. Deep Anode Hole Concrete Sealing Materials
6. Deep Anode Hole Bentonite Sealing Material
7. Pipe Lead And Bond Wire
8. Connectors
9. CP Test Stations
10. Below Grade CP Test Boxes
11. Reference Electrodes
12. Pipe Flange Insulating Kit
13. Polarization Cell
14. Monolithic Insulating Joints
15. Coating For Buried Insulated Pipe Flanges And Uncoated Pipe Specials
16. Plastic Warning Tape
17. Alumino-Thermic Weld Kits
18. Weld Coating
19. Concrete
D. Certification by the Contractor’s Corrosion Engineer stating that the corrosion protection criteria in these specifications have been met.

1.06 QUALITY ASSURANCE

A. The criteria used to indicate adequate corrosion protection of the steel pipeline shall be in accordance with NACE Standard RP0169.

B. The installation of the cathodic protection system’s electrical components shall conform to the National Electrical Code, applicable local codes, and the Recommended Practices of NACE Standards RP0169 and RP0575.

C. Provide all materials, equipment, labor, and supervision necessary for the completion of all installations and testing.

D. Obtain the services of a Corrosion Engineer to inspect and test the installation of the cathodic protection system. The Corrosion Engineer shall be a registered professional engineer with certification or licensing that includes education and experience in cathodic protection of buried or submerged metal structures, or a person accredited or certified by the National Association of Corrosion Engineers at the level of Corrosion Specialist or Cathodic Protection Specialist (i.e. NACE CP Level 4). Such a person shall have not less than five years experience inspecting pipeline cathodic protection systems.

E. Obtain the services of a Cathodic Protection Technician to inspect and test the installation of the cathodic protection system. The Cathodic Protection Technician refers to a person accredited or certified by the National Association of Corrosion Engineers at the level of Cathodic Protection Technician (i.e. NACE CP Level 2). Such a person shall have not less than five years experience inspecting pipeline cathodic protection systems.

F. Cathodic protection well drillers must have completed the installation of a minimum of five successful cathodic protection deep well anode projects greater than 100 feet deep and must possess a valid California C-57 Well Driller’s License.

G. Maintain record drawings for the cathodic protection system throughout the installation of the equipment. Properly identify all items of equipment and material. Show the exact locations of all rectifiers, anodes, buried wires, CP test boxes, and insulated pipe flanges using dimensional ties to existing structures or survey monuments. Record all changes by using a red pen or red pencil on full size drawings.

PART 2 – MATERIALS

2.01 GENERAL

A. Provide cathodic protection system materials and equipment that are new, undamaged, and in the original packaging marked with the manufacturer’s name or trademark. The materials and equipment shall be of the manufacturer’s latest standard design and shall be fully compatible to provide a complete and functional cathodic protection system.

2.02 IMPRESSED CURRENT ANODES

A. Cast Iron Anodes: High silicon cast iron anodes shall be tubular with center connections. Anodes with any cracks, inclusions, blowholes, or other defects shall not be used. All foreign matter shall be removed from the anodes before installation. Cast iron anodes shall be Anotec #2660 (50 lb - 2.6 inches by 60 inches), Anotec #2684 (70 lb - 2.6 inches by 84 inches), Durichlor #TA-3 (63 lb - 2.66 inches by 84 inches), or equal. Cast iron anodes shall have the following composition by weight:
### Component Composition by Weight

<table>
<thead>
<tr>
<th>Component</th>
<th>Composition by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silicon</td>
<td>14.20 percent to 14.75 percent</td>
</tr>
<tr>
<td>Manganese</td>
<td>1.50 percent maximum</td>
</tr>
<tr>
<td>Carbon</td>
<td>0.70 percent to 1.10 percent</td>
</tr>
<tr>
<td>Chromium</td>
<td>3.25 percent to 5.00 percent</td>
</tr>
<tr>
<td>Copper</td>
<td>0.50 percent maximum</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>0.20 percent maximum</td>
</tr>
<tr>
<td>Iron</td>
<td>Remainder</td>
</tr>
</tbody>
</table>

B. Mixed Metal Oxide Anodes: Mixed metal oxide anodes shall be tubular with center connections. The anode substrate shall be high purity titanium meeting the requirements of ASTM B338 Grades 1 or 2. The titanium substrate shall be coated by thermal decomposition of mixed metal oxide salts of the platinum group of metals to produce a crystalline, anhydrous, acid resistant coating that is highly conductive to anodic current flow. The thickness of the mixed metal oxide coating shall be designed by the manufacturer using empirical accelerated life testing to be capable of sustaining a 100 ampere per square meter anodic current density in an oxygen-generating electrolyte at 150 degree F for a period of not less than 20 years. A copy of an independent testing laboratory’s report to certify the conformance of the anodes to the preceding requirement shall be furnished, upon request, to the Engineer at no extra cost. Use ELTECH Tubular Lida Anodes or TELPRO Tubular MMO Anodes or equal.

C. Anode Weight and Dimensions: The diameter, length, type, and quantity of the impressed current anodes shall be designed such that they are capable of continuously discharging the rectifier’s full rated capacity for a minimum period of 20 years. The dimensions of the anodes shall be as shown on the Plans.

D. Anode Wire: The anode lead wire shall be minimum No. 8 AWG stranded copper, single conductor cable with a dual layer of insulation. Wire insulation shall be black or red in color. The inner insulation shall be a minimum 20 mil thick chlorine gas resistant ethylene-chlorotrifluoroethylene (Halar) extruded insulation. The outer insulation layer shall be 65 mil thick high molecular weight polyethylene extruded insulation conforming to ASTM D 1248, Type 1, Class A, Category 5, Grades E4 and E5.

E. Wire Connection: The lead wire to anode connection shall be factory assembled. The lead wire shall be center connected using a permanent compression type connector, which provides an electrical contact resistance less than 0.02 Ohms. After the center connection is made and tested for electrical resistance, the internal area of the tubular anode shall be completely filled on both ends with an electrical potting compound so as to achieve a durable watertight connection. Provide a 12 inch long protective Teflon tube around the wire and embed it two inches into the electrical potting compound.

F. Wire Length: Anode lead wires shall be sufficiently long to reach the rectifier or anode junction box (whichever is closest) without splicing. Buried splices in anode wires are not permissible. Anode wires shall be protected from damage during shipping and installation. Any damaged anode wire shall be grounds for rejection of the entire anode assembly.

G. Anode Centralizer: A centralizing device shall be attached to both ends of all impressed current anodes installed in coke backfill. The centralizer shall be designed to hold the anode away from the vent pipe and sides of the drilled hole so that there is a minimum one inch thick layer of coke backfill surrounding all surfaces of the anode. The centralizer shall be constructed of carbon steel or stainless steel as shown in the Plans.
2.03 CATHODIC PROTECTION RECTIFIERS

A. General: Rectifier shall be capable of supplying its full rated DC output continuously at an ambient temperature of 112 degree F in full sunlight with an expected life of 10 years minimum. Rectifier shall be a product of a firm that regularly produces cathodic protection rectifiers.

B. The rectifier’s output ratings in DC volts and DC amps shall be shown on the Plans showing the rectifier installation details.

C. Transformer and output adjustments: DC output shall be adjusted manually by transformer tap bars. Provide six coarse and six fine transformer tap settings for a total of 36 equal output increments. Transformer shall conform to NEMA ST1 (specialty transformers).

D. Double AC Input Ratings: The rectifier’s transformer shall be rated for operation with either 120 or 240 Volt AC, single phase, 60 Hertz input voltages. The rectifier shall be designed with manually changeable buss bars to enable changing the input voltage between 120 and 240 volts while maintaining the nominal DC output voltage and amperage ratings.

E. The rectifiers shall be designed to be capable of operating with a 120 Volt AC single phase 60 Hertz input while the buss bars are set at 240 Volts in order to reduce the maximum DC output voltage rating by 50 percent while maintaining the nominal DC output amperage rating.

F. Cooling and enclosure: Air-cooled type. Do not provide an enclosure. Rack mount all components on four vertical supports so as to be free standing when mounted on a flat horizontal surface. The rectifier assembly will be mounted inside a separate larger ornamental electrical enclosure as shown in the Plans. In order to fit inside the ornamental enclosure the maximum dimensions of the rectifier shall not exceed 21 inches high by 18 inches wide by 13 inches deep.

G. Diodes: Silicon diodes connected in such a manner to provide full wave rectification.

H. Overall efficiency: Min 65 percent when operated at full output. Provide bench test quality control checklist of efficiency testing.

I. Meters: Provide separate voltmeter and ammeter, minimum two inch round faceplate, 2 percent full-scale accuracy. Provide an on-off toggle switch for each meter.

J. Main Circuit Breaker: The rectifier shall have a molded case thermal magnetic circuit breakers conforming to UL489. The breaker shall be sized for 120 percent to 200 percent of the normal operating current at full rated output.

K. Surge protection: Protect silicon diodes by use of AC and DC lightning arrestors or metal oxide varistors against overvoltage surges and by current-limiting devices against overcurrent surges.

L. Fuses: Provide easily accessible replaceable fuses or thermal magnetic circuit breaker switches in the AC secondary, DC positive and DC negative circuits.

M. Spare parts: Provide two spare units for all DC and AC fuses (or circuit breakers), all lighting arrestors or MOV’s, and one extra sets of transformer tap bars and hardware. Place spare parts in a heavy duty plastic box and label it "SPARE PARTS".

N. Operating manual: Provide three copies of the rectifier operating manual complete with a laminated spare parts list and a laminated wiring diagram.
2.04 COKE BACKFILL

A. Fine Spherical Grained Coke Backfill: Use fine spherical grained coke for mixed metal oxide anodes. The bulk density shall be between 62 and 66 pounds per cubic foot. The grains shall be spherical to prevent bridging problems associated with installations into deep anode groundbeds. The grain size shall be such that 90 percent will pass through a No. 4 screen and greater than 80 percent shall be retained on a 20 mesh screen. The electrical resistivity shall be less than or equal to 0.03 Ohm cm when compressed at 150 pounds per square inch. The carbon content as measured by the “loss of ignition method” shall be minimum 99.9 percent. The coke backfill shall be Asbury Graphite of California product No. 4518, or equal.

B. Coarse Grained Coke Backfill: For cast iron anodes, either the fine spherical grain or the coarse grain type of coke is acceptable. The bulk density shall be between 48 pounds and 53 pounds per cubic foot. The grain size shall be such that 75 percent will pass through a No. 8 mesh screen and greater than 70 percent shall be retained on a 60 mesh screen. The electrical resistivity shall be less than or equal to 0.05 Ohm cm when compressed at 150 pounds per square inch. The carbon content as measured by the “loss of ignition method” shall be minimum 99.0 percent. The coke backfill shall be Asbury Graphite of California product No. 218-R, or equal.

2.05 ANODE VENT PIPE

A. Anode vent pipe shall be two inch diameter SCH 40 PVC pipe with slots cut in the transverse direction per the Plans. The slots shall be 0.062 inch wide by 1.30 inches long as measured on the inside diameter of the pipe. The slots shall be regularly spaced on the pipe in three columns with one inch of solid pipe between each open slot (measured along the axis of the pipe) to provide a minimum open area of 0.8 square inches per foot of vent pipe. The vent pipe shall have flush threaded joints per ASTM F480. Solvent welded slip fit joints with or without reinforcement screws are not allowed. Seal the bottom end of the vent pipe with an end cap. Temporarily seal the top end of the vent pipe with duct tape during the anode well installation work to prevent contamination of the inside of the vent pipe.

2.06 DEEP ANODE HOLE CONCRETE SEALING MATERIALS

A. Concrete shall be Class D per Section 03000.

2.07 DEEP ANODE HOLE BENTONITE SEALING MATERIAL

A. The bentonite well sealing material shall be naturally occurring Wyoming sodium bentonite clay mined from specially selected ore bodies, which exhibit a high swelling capability. It shall be specifically manufactured to create a stable, permanent, below-grade seal in monitoring wells and water wells.

B. The bentonite particles shall have a minimum bulk density of 68.8 lb/cf and be size graded so that 100 percent of the particles pass through a 3/8 inch screen and all the particles are retained on a 1/4 inch screen.

C. The bentonite product shall be certified by the National Sanitation Foundation for use in the construction of potable water wells.

D. The bentonite well sealing material shall be Falcon GDP Inc.’s “HOLEPLUG - SIZE 3/8 INCH CHIPS”, Falcon “BARIOD BENTONITE PELLETS - SIZE 3/8 INCH,” or equal.

2.08 PIPE LEAD AND BOND WIRE

A. Use stranded copper wire. Wires with cut or damaged insulation are not acceptable and replacement of the entire lead will be required. Wires shall be sufficient length to extend from the point of installation on
the pipeline to the appropriate corrosion monitoring test box without splices and provide for a minimum of 24 inches of slack within the test box.

B. Direct Buried CP Wires: Wires shall be stranded copper that conform to ASTM B3 and ASTM B8. All test wires shall be minimum No. 8 AWG. For identification purposes, larger gauge wires shall be used where test wires from two or more buried structures terminate in the same test box. Test wires shall have a 7/64 inch thick HMW-PE insulation specifically designed for cathodic protection service and suitable for direct burial in corrosive soil, conforming to ASTM D1248, Type I, Grade J3, Class C, Category 5 (HMW-PE Type CP).

C. CP Wires in Conduit: Wires shall be stranded copper that conform to ASTM B3 and ASTM B8. All test wires shall be minimum No. 8 AWG. For identification purposes, larger gauge wires shall be used where test wires from two or more buried structures terminate in the same test box. Test wires shall have THWN wire insulation that conforms to UL83. Wire insulation color shall be as shown in the Plans.

D. Pipe Joint Bonding Wire: Wire shall be No. 2 AWG and shall have 7/64 inch thick HMW-PE insulation specifically designed for cathodic protection service and suitable for direct burial in corrosive soil, conforming to ASTM D1248, Type I, Grade J3, Class C, Category 5 (HMW-PE Type CP). Install bond wires at the minimum length required.

2.09 CONNECTORS

A. Split bolts shall be compact, high strength, high conductivity copper alloy, have free-running threads and easy to grip wrench flats. All current carrying bolts and hardware shall be copper alloy.

B. Cable connection lugs for rectifiers, anode junction boxes, and CP test stations shall be constructed from high conductivity high strength copper alloy such as Ilsco Type SLU, Ilsco Type CP, or equal. Cable connection lugs shall not have any aluminum or steel subcomponents. All current carrying bolts and hardware shall be copper alloy.

2.10 CP TEST STATIONS

A. Junction boxes for above grade cathodic protection test stations installations shall be UL listed enclosures, and have dimensional and electrical stability over the environmental range it will be exposed. Junction boxes shall not rust, corrode, shatter, peel or absorb water. Cabinet shall have a stainless steel lockable quick release hasp and stainless steel hinged and rain-tight cover. Test stations shall have dimensional and electrical stability from minus 20 degree F to plus 175 degree F and be stable under ultraviolet exposure. Junction boxes shall be the Stahlin fiberglass JxxxxHPL series, the Hoffman stainless steel Type 304 or 316 A-xxxxCHNFSS series, or equal.

B. Each CP Test Station or CP Junction Box shall include a cross-laminated phenolic terminal board with a minimum thickness of 1/4 inch. The terminal board shall contain individual lugs for each wire entering the test station or junction box.

C. Anode Junction Box Shunts: The shunt resistance shall be such that a five Amp current causes a voltage drop of 50 millivolts (i.e. 0.010 ohms). Shunts shall be the 1/2 inch wide by 3 3/4 inch long flat manganin ribbon style such as the Agra J. B. shunt or the Holloway Type SW.

D. Wire and cable identification markers. Provide a durable wire identification tag for each cable. Acceptable tags are one inch diameter by 1/16 inch thick die stamped brass or stainless steel tags. Secure the tags to each cable with a heavy duty nylon wire tie, twisted bare No. 12 copper wire, or equal fastener. Die stamp the tags per the job specific identification legend on the Plans.
2.11 BELOW GRADE CP TEST BOXES

A. Provide an electrical pull box or concrete valve box for all below grade CP Test Stations. Boxes shall be installed outside of any roads or parking lots. Where traffic loading of the boxes is required, they shall be designed to withstand H-20 traffic loads. Boxes shall be a minimum of 10-3/8 inches inside diameter, 12 inches deep, and have a cast iron cover. Covers for test stations shall have the words "SDCWA CP TEST" cast or welded thereon. Letters shall be minimum 3/4 inches tall and 1/4 inch raised from the surrounding flat area. Use Christy Concrete Products, G5, or equal.

2.12 REFERENCE ELECTRODES

A. Reference electrodes shall be the copper-copper-sulfate type, suitable for direct burial and designed to remain stable for at least 20 years.

B. The reference electrode shall have a minimum sensing surface area of eight square inches. It shall be capable of maintaining a stable potential within plus or minus 10 millivolts to that of another new reference electrode while a three microampere electrical current is applied.

C. Reference electrode shall contain a barrier to inhibit migration of chloride ions from the soil into the reference electrode.

D. Reference electrode lead wire shall be No. 14 AWG, stranded copper, with RHH-RHW yellow colored insulation and shall be silver soldered to the copper core of the reference electrode with the connection epoxy sealed by the manufacturer.

E. Use Stelth 2 Model SRE-007-CUY by Borin Manufacturing, or Staperm Model CU-1-UGPC by GMC Corrosion, or equal.

2.13 PIPE FLANGE INSULATING KIT

A. For purposes of this specification, the terms “Pipe Flange Insulating Kit”, “Insulated Flange”, “Insulated Joint”, and “Dielectric Flange” are used synonymously.

B. Pipe flange insulating kit materials shall be designated by the manufacturer as suitable for service at the operating temperatures and pressures specified on the Plans.

C. Flange insulating kits shall consist of a one piece, full-face, insulating gasket, an insulating sleeve for each bolt, insulating washers, and steel washers. For nominal pipe diameters up to and including 36 inches, provide one insulating washer and one steel washer on each side of the flange. For nominal pipe diameters greater than 36 inches, the insulating washers shall be installed sandwiched between a pair of matching steel washers on each side of the flange.

D. Insulating Gasket: Insulating gasket retainers shall be full face, Type E, NEMA G10 epoxy glass retainers with a nitrile (Buna-N) rectangular cross section O-ring seal. Minimum total gasket thickness shall not be less than 1/8 inch. The gasket shall have the same outside diameter as the pipe flange. For cement mortar lined pipe, the gasket’s inside diameter shall be one inch greater than the nominal pipe diameter. For epoxy lined pipe, the gasket’s inside diameter shall be equal to the nominal pipe diameter. Dielectric strength shall be not less than 550 volts per mil, and compressive strength shall be not less than 50,000 psi. The manufacturer’s name and date of manufacture shall be marked on both sides of the gasket with two inch tall letters. The gasket shall be installed within six months of the date of manufacture. Use psi Linebacker insulating gasket, or equal.

E. Insulating Sleeves: Provide full length, one piece, NEMA G10 epoxy glass insulating flange bolt sleeves. Dielectric strength shall be not less than 400 volts per mil. The length of the insulating sleeves...
shall provide an air gap between the end of the insulating sleeve and inside surface of the stud bolt nut with a tolerance of 1/32 inch minimum and 1/8 inch maximum.

F. Insulating Washers: Insulating washers shall be NEMA G-10 epoxy glass with a minimum thickness of 1/8 inch. Dielectric strength shall not be less than 550 volts per mil, and compressive strength shall not be less than 50,000 psi. The insulating washer’s inside diameter shall be sized to fit over the insulating sleeve’s outside diameter.

G. Provide minimum 1/8 inch thick steel washers for placement over the insulating washers. The inside and outside diameter of the steel washers shall match those of the insulating washers. The steel washers must be able to freely rotate around the insulating sleeve. Attention must be paid to the fit between the steel washers and the insulating sleeve in order to avoid the washers twisting the sleeves when the flange bolts are torqued.

H. Provide four extra insulating sleeves and eight extra insulating washers for each insulating flange upon successful inspection of the insulating flange.

2.14 POLARIZATION CELL

A. Type and Rating: Solid-state device designed to provide direct current electrical isolation and simultaneous alternating current electrical grounding. Ratings are to be as follows:

1. 60 Hz Current (short duration, three cycles): 5,000 amperes AC root mean square symmetrical.

2. 60 Hz Current (steady-state, 65 degrees C ambient): 40 amperes AC RMS symmetrical.

3. Lightning Surge Current: 100,000 amperes.

4. DC Current Leakage (driving voltage 1VDC, 65 degree C): Less than 0.1 milliampere.

5. Ambient Operating Temperature: Minus 40 degree F to plus 150 degree F.


7. Manufacturer and Product: Dairyland Electrical Industries, Model PCR-3.7KA, or equal.

B. Bus Bars and Mounting Hardware: All components required for mounting provided by polarization cell manufacturer, as shown on the Plans. Bus bar for mounting polarization cell to pipe flanges shall be copper conforming to ASTM B 124, Alloy C110.

2.15 MONOLITHIC INSULATING JOINTS

A. The Monolithic Insulating Joints shall be installed in the piping system at the locations shown on the Plans. MIJs shall be boltless, factory assembled, and welded into the piping section.

B. The insulating component shall be as recommended by the MIJ manufacturer and as in writing by the Engineer. The steel components of the MIJ shall match the pipe section to which it is attached.

C. Each pipe section with an MIJ shall be hydrostatic tested to 1-1/2 times the rated operating pressure in accordance. Testing shall be conducted between testing plates or end caps to ensure the most arduous conditions and shall be witnessed by the Engineer.

D. The manufacturer shall inspect all welds used to construct the MIJ with ultrasonic, magnetic particle, and dye penetrant tests. The manufacturer shall test each MIJ for electrical isolation after the completion of
hydrostatic tests. Testing shall be witnessed by the Engineer. Electrical resistance shall be a minimum of five Megohms. Written test results shall be submitted to the Engineer.

E. Each MIJ shall be provided with a lining material that matches the type and thickness of the lining material of the pipe to which it is attached.

F. Each MIJ shall be externally coated with a two part epoxy coating applied to a minimum dry film thickness of 0.010 inches to within two inches of each end. Each pipe section with a MIJ shall be coated with one inch thick cement mortar conforming to Section 09871. The steel reinforcement in the cement mortar coating shall be held back two inches from both sides of the MIJ’s insulating ring so as to avoid creating a metallic path across the insulated gap.

G. Electrical isolation tests shall be repeated by the Engineer at the job site when the MIJ is delivered, before the MIJ is attached to the pipeline, and before any field applied linings or coatings are applied to it. MIJ electrical resistance shall be a minimum of 5 Megohms.

H. The MIJ shall be one of the following trademark/trade name products: Iso-Joint, Iso-Bloc, Electro-Stop, or equal.

2.16 COATING FOR BURIED INSULATED PIPE FLANGES AND UNCOATED PIPE SPECIALS

A. Apply a wax tape coating system, which conforms to AWWA C217 and consists of three parts: surface primer, wax-tape, and outer covering.

B. The primer shall be a blend of petrolatum, plasticizer, and corrosion inhibitors having a paste like consistency. It shall have a pour point of 100 degree F to 110 degree F and a flash point of 350 degree F. Use Trenton Wax-Tape Primer, or equal.

C. The wax-tape shall consist of a synthetic-fiber felt, saturated with a blend of high melt microcrystalline wax, solvents, and corrosion inhibitors, forming a tape coating that is easily formable over irregular surfaces and which firms up after application. The tape shall have a saturant pour point between 125 degree F and 130 degree F and a dielectric strength equal to a minimum of 100 volts per mil. Tape thickness shall be 70 mils to 90 mils in six inch wide rolls. Use Trenton No. 1 wax-tape, or equal.

D. The outer covering shall consist of two layers of a plastic wrapper. The plastic wrapper material shall consist of three ten mil thick clear polyvinylidene chloride, high cling membranes wound together as a single sheet. Use Trenton Poly-Ply, or equal.

2.17 PLASTIC WARNING TAPE

A. Plastic warning tape for horizontal runs of buried leads in cable trenches shall be a minimum of four mils thick and six inches wide, inert yellow plastic film designed for prolonged use underground. The tape shall have the words, "CAUTION CATHODIC PROTECTION CABLE BELOW," or similar, clearly visible in repeating patterns along its entire length.

2.18 ALUMINO-THERMIC WELD KITS

A. Exothermic weld material shall be a mixture of copper oxide and aluminum, packaged by size in plastic tubes as shown in the Plans. The materials shall be non-explosive and not subject to spontaneous ignition.

B. Exothermic weld material and accessories shall be Erico Products, Inc., ThermOweld® or equal. Materials from different manufacturers shall not be mixed.
2.19 WELD COATING

A. Coating for all welds shall be a cold-applied, fast drying mastic consisting of bituminous resin and solvents. The minimum percentage of solids shall be 80 percent.

2.20 CONCRETE

A. Concrete used for rectifier and cathodic protection test station installations shall be Class B per Section 03000.

B. Concrete used for CP conduit trenches shall be Class D per Section 03000. The concrete shall be mixed with two lbs of red dye per 100 lbs of cement.

PART 3 – EXECUTION

3.01 INSTALLATION OF RECTIFIERS

A. Order and install rectifier without the manufacturer’s standard outer electrical enclosure. Assemble the rectifier inside a larger electrical enclosure as shown in the Plans. Make wiring connections as indicated on the Plans.

B. Handle wire to prevent stretching or kinking of the conductors or damage to the insulation. Use lubricants when pulling wires into conduits.

C. Install an electrical grounding system, which conforms with the most recent National Electric Code and Section 16450. In addition to the applicable N.E.C. requirements, the electrical resistance of the rectifier’s electrical enclosure, measured with respect to remote soil, shall be less than or equal to five ohms. At all locations direct bury a minimum 20 feet of bare soft drawn No. 2 AWG stranded copper cable at a minimum burial depth of three feet. If necessary, construct additional direct buried ground cable and/or provide a six inch layer of slurried powdered bentonite in the ground cable trench to sufficiently reduce the soil contact resistance. Bond the No. 2 AWG cable directly to the enclosure inside the right rear compartment.

3.02 DEEP WELL ANODE HOLE DRILLING

A. For purposes of this specification, the terms “Deep Anode Groundbed” and “Deep Well Anode” are used synonymously to refer to a hole drilled to a depth of 50 feet or greater into which cathodic protection anodes are lowered and backfilled.

B. Obtain a cathodic protection well drilling permit from the County of San Diego, Department of Environmental Health and pay all permit fees. A copy of the permit shall be submitted to the Engineer a minimum of 30 days before drilling commences.

C. The contractor is responsible to ensure that the deep well anode installation is constructed in accordance with the State of California, Department of Water Resources Bulletin 74-90 - Cathodic Protection Well Standards.

D. Drill the deep anode hole where shown and to the depth indicated on the Plans. Unless otherwise shown on the Plans, the standard anode hole shall be 10-5/8 inch diameter. The anode hole shall be drilled sufficiently straight and true to allow the anodes to be installed without binding or straining the anode cables. If using rotary tricone drilling bit equipment, select the type and consistency of drilling fluids to be consistent with the soil characteristics.

E. The term “hard rock” is defined in this specification (for the purpose of deep well anode hole drilling only) as a condition where a drilling rig in good working condition experiences an average drilling rate of
less than or equal to one foot in 12 minutes for a minimum continuous period of one hour (i.e. less than five feet in 60 continuous minutes) while operating with a minimum down hole drill bit pressure of 50 percent of the equipment’s full rating. If hard rock drilling conditions are encountered before drilling to the depth on the Plans, notify the Engineer immediately.

F. Surface Casing: Install a permanent PVC pipe surface casing from grade down to minus 50 foot elevation. Use only PVC pipe with ASTM F480 flush threaded joints in order to maintain the required two inch annular space between the pipe’s outside diameter and the drilled hole. Do not use screws to reinforce the well casing pipe joints. Do not introduce anything into the anode well that has a sharp or abrasive surface that could damage the anode wires. Ten foot or 20 foot lengths of pipe may be used.

G. Optional Steel Well Casings: The use of temporary steel well casings other than the six inch PVC well casing shown in the Plans may be necessary to hold the hole open depending of the soil characteristics and the type of drilling equipment used. If steel casings are used, no portion of the steel casing may be left in the top “Non-Active Zone” of the anode well upon completion.

3.03 ANODE WIRE CONNECTION TEST

A. Measure and record the resistance between each anode and the end of its lead wire using a 97 Hertz square wave null balancing ohmmeter, such as the Model 400 Nilsson Soil Resistance Meter and the four-wire resistance technique.

B. Anode Wire Resistance Test: This test must be performed with the anode wire uncoiled from the manufacturer’s wire spools in order to avoid measurement error due to the electrical reactance of coiled wire. Perform this test by connecting the meter’s P1 and C1 terminals to the end of the anode wire and then connecting the meter’s P2 and C2 terminals to the anode using a pair of sturdy clamps or vise grips. Make these two temporary connections to the tubular anode directly over the internal wire connection. Verify the anode-wire connection resistances are less than 0.05 Ohms, or less than the manufacturer’s stated connection resistances, whichever value is greater. Record the resistance readings and submit to the Engineer.

3.04 ELECTRICAL LOGGING OF DEEP ANODE HOLES

A. Electrical Resistivity Log: After the final hole depth is achieved and the drilling mud has been thinned out, log the electrical resistivity of the hole using a test anode or pipe not more than five feet long. If the hole was drilled without drilling mud, fill the hole with potable water and maintain the water level above minus ten foot elevation during this test. Measure the resistance between the test anode and electrically remote soil starting at the top of the hole and at ten foot intervals to the bottom of the hole. Perform the resistance measurements using the three wire method and a 97 Hertz square wave null balancing ohmmeter such as the Model 400 Nilsson Soil Resistance Meter.

B. Electrical Resistivity Log Procedure: Perform this test by hammering into the ground two steel survey stakes to a minimum depth of 12 inches below grade. Pour a minimum 1/2 gallon of water on the soil around each survey stake. The farthest survey stake shall be located five times the anode hole depth away from the anode hole (electrically remote). The second survey stake shall be located 62 percent of this distance away. The two survey stakes and the anode hole shall lie in a straight line.

C. Connect the meter’s P1 and C1 terminals to the end of the test anode wire. Using two long wire reels, connect the meter’s P2 terminal to the nearest survey stake and the C2 terminal to the farthest survey stake. Connect the C2 terminal to the farthest survey stake using a minimum No. 14 AWG wire. Operate the meter to obtain a null reading at each ten foot depth increment. Record these readings and submit to the Engineer.

D. At the discretion of the Engineer, a buried pipeline with a sufficiently low electrical resistance to earth may be substituted for the two survey stakes. Using this method, make two separate wire connections to
the pipeline and two wire connections to the test anode wire. Connect the meter’s P1 and C1 terminals to the end of the test anode wire. Connect the meter’s P2 terminal to one wire and the C2 terminal to the other. Use a minimum No. 14 AWG wire to connect the C2 terminal to the pipeline. Operate the meter to obtain a null reading at each ten foot depth increment. Record these readings and submit to the Engineer.

3.05 ANODE INSTALLATION IN DEEP ANODE HOLES

A. Before lowering the anodes into the hole, carefully examine the wire insulation on each anode. Damaged anodes or anode cables with cracks, entrapped air bubbles, inclusions or other defects shall not be used. Defective anodes shall be removed from the work site no later than the conclusion of the workday. Label the anode wires with colored tape or paint to mark the intended final depth. Use additional colored tape or paint to mark the wires in two increments of ten feet above and below the intended installation depth.

B. The final installed depth of the anodes shall be as shown in the Plans. Variances with the depths as shown on the Plans may be made with the Engineer’s approval based on the electrical resistivity log of the hole. Anodes shall not be closer together than three feet (end to end) nor shall they be located or extend up out of the “Active Anode Zone” shown on the Plans. Contractor shall record the final installed depth of each anode and submit it to the Engineer.

C. Anode Wire Length: Supply anodes with sufficient wire lengths to run continuous from the installed anode depth to the rectifier without any splices. If an alternate anode hole location is shown on the Plans (where hard rock drilling conditions are expected), supply the anodes with sufficient length to be installed in the anode hole farthest from the rectifier. Exercise extreme care not to damage the anode wire insulation during the entire installation procedure. No splices are allowed in the anode wires.

D. Installing Anodes: Attach the first anode to a centralizer using a stainless steel hose type clamp. Next attach the first section of slotted two inch diameter SCH 40 Anode Vent Pipe to the same centralizer.

E. Lower the anode vent pipe/anode/centralizer assembly into the hole the appropriate distance until the next anode and centralizer distance is reached. Secure the downhole assembly by wrapping the anode lead wires around a smooth pipe no smaller than four inches in diameter. Do not kink or tightly bend the anode wires around anything smaller than a four inch diameter smooth rigid surface. Do not tie knots with the anode lead wires.

F. Assemble the next anode and centralizer to the downhole column and lower into hole. Assemble the next section of anode vent pipe by threading it on to the downhole section.

G. Anode Wire Identity: As the anodes are lowered into the hole, label each wire. Label the first anode in the hole as Anode No. 1 and so on. Preserve the wire identities until all the anodes wires are secured to the numbered shunts inside the rectifier enclosure.

H. Temporary Anode Wire Protection: Coil the anode wires into a neat bundle and provide complete physical protection by covering them with sand bags off to the side of the well.

3.06 COKE INSTALLATION IN DEEP ANODE HOLES

A. After all the anodes and vent pipe are in place in the deep anode hole, but before any coke backfill is added, measure the resistance to remote soil of each anode in the same manner described in the paragraph entitled “ELECTRICAL LOGGING OF DEEP ANODE HOLES”.

B. Bottom Pumping Installation Method: This method is recommended but not mandatory. Install the coke in slurry form with a tremie pipe by pumping it into the bottom of the hole first. Do not extend coke higher than 15 feet above the top of the top anode.
C. Top Loading Installation Method: If this method is used, careful attention must be paid towards avoidance of coke plugs which could bridge the hole and prevent the complete encapsulation of the anodes by the coke. Install the coke by pouring it into the hole from the top. Thoroughly wet the coke as it is added to aid in the settling process. Do not extend the coke column higher than 15 feet above the top of the top anode.

D. During the installation of the coke slurry, monitor the electrical resistance to earth of the bottom anode until the value decreases a minimum of 25 percent. The abrupt decrease in resistance indicates proper settling of the highly conductive coke around it. Monitor the resistance of the other anodes until it is evident that the coke has reached the top anode. If there is any evidence of bridging, measures shall be taken to insure proper settling. The volume of coke added to the hole shall be compared with hole volume to insure that bridging, blockage, or collapse of the hole has not occurred.

E. 24 Hour Mandatory Waiting Period: A full 24 hour waiting period must be allowed after the completion of the coke loading process to allow for coke settlement and its natural compaction process. After 24 hours, use a minimum one inch diameter steel pipe to probe the hole to determine the depth of the top of the coke. If more coke is needed to bring it up to the depth indicated, pour a calculated amount of coke into hole again. If more than 20 feet of coke is required to be added, an additional 24 hour waiting period must be allowed and the preceding process repeated.

F. Unused coke and excess drilling mud and excavated earth shall be hauled away and/or disposed by the Contractor in a manner conforming to state and local regulations.

3.07 DEEP ANODE HOLE WATER SEAL MATERIALS

A. Bentonite: Pour a calculated amount of bentonite pellets into the annular space between the drilled hole and the PVC well casing to produce a minimum five foot long water seal at the bottom of the solid PVC well casing.

B. Cement or Grout Seal: Once the bentonite has settled, pump neat cement or grout into the annular space between the drilled hole and the solid PVC well casing. Use a one to 1-1/2 inch diameter tremie pipe to prevent free falling of the sealing material more than 30 feet in the annular space. Do not top load the sealing material.

3.08 FINISHING DEEP ANODE WELLHEADS

A. PVC Wellhead Fittings: Use sand paper to smooth the outside diameter of the top six inch pipe nipple and the inside of the top six inch end cap to allow a smooth fit so that it can be removed by hand. Do not use PVC cement on the end cap. Do not drill any holes into the end cap for venting purposes. The anode well is to be vented solely by the anode vent pipe as shown in the Plans.

B. Wellhead Finishing: Prepare concrete formwork, reinforcing steel, vent pipe, electrical conduit, and concrete electrical pull box for finishing the top of the anode well as shown in the Plans.

C. Anode Wire Trench: Trench the anode wire conduit and anode vent pipe as shown in the Plans. Maintain a smooth minimum slope in the run of the anode vent pipe of 1:75 away from the deep anode hole.

3.09 INSTALLATION OF REFERENCE ELECTRODE

A. Measure the accuracy of each copper/copper sulfate reference electrode before installation by measuring the DC voltage difference between it and one or more reference electrodes of known accuracy. The measurements shall be less than plus or minus 0.010 DC volts for all reference electrodes. Perform these measurements after totally submerging the reference electrodes in a five gallon bucket of potable water for a minimum period of 15 minutes. Brackish water or saltwater will not be allowed. Provide five days written notice to the Engineer to allow these tests to be witnessed.
B. Install the copper/copper sulfate reference electrodes as shown on the Plans. Provide a minimum 24 inches of slack wire around the reference electrode to allow for movement during backfill and soil compaction. Exercise care so as not to damage or pierce the insulation of the reference electrode lead wire. Cover the reference electrode with six inches of native rock free soil and saturate it with a minimum five gallons of potable drinking water. Backfill as shown in the Plans.

3.10 CATHODIC TEST STATION

A. For purposes of this specification, the terms “Cathodic Test Station”, “Cathodic Protection Test Station”, “Cathodic Test Box, and “CP Test Box” are used synonymously to refer to a group of test wires welded to a pipeline, casing, or tunnel which are trenched to an electrical junction box, flush mounted valve box, or flush mounted meter box.

B. Construct Cathodic Test Stations to enable periodic cathodic protection system monitoring. Unless otherwise shown on the Plans, provide CTS at the following locations:

1. Pipe Crossing CTS - Provide four-wire CTS at all locations where Water Authority cathodically protected pipelines cross other cathodically protected pipelines to enable testing the electrical interaction between the two pipelines. Provide a pair of test wires welded to each pipeline.

2. Casing Isolation CTS - Provide Casing Isolation CTS at all locations where Water Authority cathodically protected pipelines run inside steel casings or steel reinforced tunnels to enable testing the integrity of electrical isolation between the pipeline and casing. Provide a pair of test wires welded to the pipeline and to the casing or tunnel.

3. Insulated Flange CTS - Provide Insulated Flange CTS for all insulated flanges. Where insulated flanges are located inside vaults, flow control facilities, and pump stations, mount the test boxes on the exterior walls of these structures to enable cathodic protection monitoring without entering the structure. Where multiple insulating flanges are connected in electrical parallel configurations, only one Insulated Flange CTS is required for each group. Provide a pair of test wires welded to the pipe on each side of the insulated flange, total four wires required. For buried insulated flanges only, provide an additional pair of pipe test wires attached to the pipe a distance of 250 feet away (plus or minus 20 feet to the nearest pipe joint) from the insulated flange, total six wires required. Provide the additional pair of pipe test wires on the side of the insulated flange, which will be cathodically protected. Use unique wire sizes or wire colors to distinguish the different pipe attachment locations.

4. Galvanic Anode Junction Boxes - Provide Anode Junction Boxes for all galvanic anode installations. Do not direct connect anodes to the pipelines. Provide an individual shunt for each anode wire to enable monitoring of individual anodes.

C. All pipelines to be monitored with a CTS shall have a minimum of two test wires welded to it.

D. Wherever possible, mount CTS boxes to the exterior walls of vaults and other structures.

E. Where flush mounted CTS are specified for a pipeline in a paved street, install the CTS boxes in areas away from traffic hazards, such as in medians or behind curbs.

F. Where flush mounted CTS are specified provide a minimum of 24 inches of slack in all test wires to enable them to be removed from the box during periodic CP system testing.

G. Where flush mounted CTS are specified for pipelines in unpaved areas place a single four inch diameter steel pipe marker post to denote the location of each test station. The marker post shall be seven feet long with the lower three feet below ground in a 16 inch diameter by 42 inch deep 3,000 psi concrete footing.
Paint the marker post with safety yellow epoxy paint. Provide four bands of white reflective safety tape at the top of the marker post. Below the reflective tape, paint the letters “CPTS” and the pipeline station number using black high gloss epoxy paint.

3.11 WIRE-TO-PIPE CONNECTIONS ON BURIED PIPE

A. Exothermically weld the CP test wires to pipelines at the nearest pipe joint to the pipeline station indicated on the Plans.

B. Install the cables with sufficient slack so that the cable insulation and conductors will not be damaged during the pipe backfilling process. Protect the cables by running them in schedule 40 PVC electrical conduit. Begin the PVC conduit within three feet of the welded connection to the pipe.

C. For dielectrically coated steel pipelines, cover the exothermically welded connection with a polyethylene weld cap. Seal all around the weld cap and any other areas of exposed steel with a bitumastic coating or a two part high build fast cure epoxy coating.

D. For cement mortar and concrete coated pipelines, cover the exothermic weld nugget and all disturbed areas of the pipeline coating with a quick cure, non-shrink, cementitious, patching compound. Apply the compound to a thickness of one inch or to match the surrounding pipe coating thickness, whichever is greater. The patching compound shall have a set time of 20 minutes, a maximum shrinkage of 0.087 percent after seven days (ASTM C 596 test method), achieve a minimum compressive strength of 3,570 psi in one day, and a minimum compressive strength of 8000 psi in 28 days (ASTM C109). Use “Jet Set Complete Repair” as manufactured by Jet Set Cement Corporation or equal.

3.12 WIRE-TO-PIPE CONNECTIONS ON EXPOSED PIPE

A. For wire-to-pipe connections inside vaults and other structures, exothermically weld the CP test wires to the pipe within one foot of the pipe-wall penetration, on the interior side. The welded connections shall be positioned so that the wires do not interfere with the installation or removal of flange bolts.

B. Paint the exothermically welded connection with a coating that matches material and color of the surrounding pipe coating.

3.13 EXOTHERMIC WELDS

A. Make wire connections to the pipeline or other structure with an exothermic weld process ("Cadweld", “ThermOweld”, or equal) per manufacturer’s recommendations.

B. Provide a minimum separation of six inches between multiple exothermic welds.

C. Remove a minimum amount of the existing coating required for placement of the weld mold on the steel structure. The steel surface must be completely clean and dry (near white metal surface preparation).

D. Test the weld integrity by striking it from the side with a two pound hammer. If the weld comes off, move away a minimum of three inches and repeat steps A through D.

E. After testing, apply weld coating.

3.14 PIPE JOINT BONDING WIRES

A. During installation of the pipe, electrically bond across all buried pipe joints, which are not circumferentially welded as shown in the Plans. Install bond wires across buried or submerged metallic in-line valves, flex couplings, bolted flanges, and fittings, except for insulated pipe flanges and monolithic insulating joints. Install bond wires using the minimum length required. For pipeline diameters less than
B. Do not install bond wires across pipe joints or pipe flanges inside valve vaults and other structures unless specifically shown on the Plans.

3.15 INSTALLATION OF INSULATING FLANGE MATERIALS

A. Install pipe flange insulating materials at the locations shown on the Plans. Install pipe flange insulating materials in accordance with the manufacturer's recommendations and NACE recommended practice RP0286, "Electrical Isolation of Cathodically Protected Pipelines." Particular attention shall be paid to properly aligning the flanges prior to inserting the insulating sleeves around flange bolts. Prevent moisture, soil, or other foreign matter from contacting any portion of the insulating joint prior to or during installation. If moisture, soil, or other foreign matter contacts any portion of the insulating joint, disassemble the entire joint, clean with a suitable solvent and dry prior to reassembling. Follow the manufacturer's recommendations regarding the torquing pattern of the bolts and the amount of torque to be used when installing the flange insulating kit. As required, use only non-conductive lubricants such as Huskey 2000 Lubricating Paste & Anti-Seize compound, 3M Super 77 Spray Adhesive, and Triflow aerosol lubricant with Teflon additive, on the flange bolts or other flange components.

3.16 POLARIZATION CELL

A. Install polarization cells at insulating flanges as shown on the Plans.

B. Mount polarization cell to pipe flanges using bus bars and bolted connections.

3.17 COATING OF BURIED INSULATED PIPE FLANGES

A. Coat buried insulated pipe flanges with a wax tape coating system in accordance with AWWA C217. The wax tape coating system shall extend over the adjacent pipe coating by a minimum 12 inches, or 18 inches away from the flange surface, whichever is greater.

B. The surfaces to receive the wax tape coating shall be clean and free of all dirt, grease, and other foreign material. Apply the primer by gloved hand or brush onto all exposed steel surfaces. Cut strips of wax tape and apply them by gloved hand around all bolts, nuts, and other irregular shapes so that there are no voids or spaces under the tape. Apply a sufficient amount of tape to completely encapsulate all exposed steel surfaces with a minimum wax tape thickness of 140 mils. Apply by hand two layers of polyvinylidene chloride, high cling membrane sheet over the wax tape coating by tightly wrapping it around the pipe such that it adheres and conforms to the wax tape. Secure the plastic wrap to the pipe with adhesive tape.

3.18 TESTING INSULATED PIPE FLANGES

A. The Contractor's Cathodic Protection Specialist, Corrosion Engineer, or Corrosion Technician shall test the electrical isolation effectiveness of each insulated pipe flange. The Contractor shall provide written notice of this testing to the Engineer a minimum of two days in advance. If the insulated pipe flange will be buried, it shall be tested for electrical isolation by the Contractor before the wax tape coating is applied and before it is connected to the pipeline. At the Engineer's option, the Water Authority may repeat this testing during or immediately after the installation of the insulting flange. Replace or repair any insulated pipe flange that is determined not to be electrically effective. The effectiveness of insulating flanges shall be determined using the following test techniques in the order shown until one of the criteria is achieved or as otherwise directed by the Engineer.
1. Electrical Potential Difference Test: Electrically bond the pipe on the vault or unburied side of the insulating flange to an electrical ground with a maximum resistance to remote soil of five Ohms. If the pipe on both sides of the insulating flange is mechanically connected to a minimum 50 feet of buried pipe, then the pipe does not need to be bonded to an electrical ground for this test. Measure the CP Potential of the pipe on both sides of the insulating flange using a copper/copper sulfate reference electrode. If the difference in CP Potentials is greater than or equal to 400 millivolts, the insulating flange is providing adequate electrical isolation. If this criterion is not met, perform the Nilsson 400 Meter Direct Resistance Test to verify the effectiveness of the insulating flange.

2. Direct Resistance Test: Measure the electrical resistance across the insulated flange using a 97 Hertz square wave null balancing ohmmeter such as the Model 400 Nilsson Soil Resistance Meter and the four-wire resistance technique. A standard handheld digital multi-test meter's ohmmeter circuit (e.g. Fluke 97 or Beckman HD110) is not suitable for properly making these resistance measurements. Perform this test by connecting the meter’s P1 and C1 terminals to one side of the insulating flange, using two wires, and then connecting the meter’s P2 and C2 terminals to the other side of the insulating flange, using two additional wires. Use vise grips or temporary exothermic welds to make the wire connections to the flange or pipe. The criterion for a pipe filled with water is a minimum measurement of five Ohms. The criterion for a dry or a partially filled pipe is a minimum measurement of 100 Ohms. If none of the applicable criteria are met, perform the Inductive Ammeter Direct Resistance Test to verify the effectiveness of the insulating flange.

3. Inductive Ammeter Direct Resistance Test: Connect two separate wires via two separate connections to the pipe on both sides of the insulating flange. Use vise grips or temporary exothermic welds to make the wire connections. Use two pairs of test wires, one for current flow, one for voltage measurement. Using the first set of test wires, apply a minimum 12 volt DC electrical current across the insulating flange. Using the second set of test wires, measure the voltage across the insulating flange developed by the DC current flow. Use an inductive ammeter hoop (e.g. Swain hoop) clamped around the pipe immediately adjacent to the insulating flange to measure the change in DC current flow in the pipe, through the insulated flange. Calculate the electrical resistance across the insulating flange in Ohms by dividing the change in DC Volts by the change in DC Amps (i.e. Ohm's Law). The criterion for a pipe filled with water is a minimum measurement of five Ohms. The criterion for a dry pipe is a minimum measurement of 100 Ohms. If either of the applicable criteria is not met, perform the NACE Insulating Flange Leakage Test, per NACE RP0286, to verify the effectiveness of the insulating flange.

4. NACE Insulating Flange Leakage Test: This test procedure shall conform to the "Leakage Test" described in the NACE Standard RP 0286, Section 8, "Field Testing and Maintenance", Figure 12. The test current used shall be between three and five DC Amps. The criterion for a pipe filled with water is a maximum “electrical leakage value” of 10 percent of the test current. The criterion for a dry pipe is a maximum “electrical leakage value” of 5 percent of the test current.

B. Individual Flange Bolt Electrical Resistance Testing: For all insulated flanges to be buried and for all other insulating flanges that do not meet any of the previous minimum criteria, measure the electrical resistance of each flange bolt to both sides of the insulated flange using a Nilsson Model 400 Soil Resistance Meter and four-wire resistance technique. The measured resistance value for each flange through-bolt shall be a minimum of 1,000 Ohms, as measured from each bolt to both flanges. This criterion applies to flange through-bolts and does not apply to valve cap bolts. If lower resistance values are measured, remove, inspect, and replace all imperfect dielectric flange bolt sleeves and washers. If an insulated flange with threaded cap bolts passes the resistance tests for all the “through-bolts” yet fails the other previous tests, remove all the threaded cap bolts, inspect and replace all imperfect dielectric flange bolt sleeve and washer materials and retest.
3.19 ELECTRICAL ISOLATION TESTING BETWEEN PIPE AND STEEL REINFORCEMENT

A. Conduct testing to demonstrate that steel reinforcement in concrete structures and pipe encasements is not in contact with buried steel pipe. Correct all contacts detected between pipe and reinforcement by removing the concrete as necessary and trimming or repositioning reinforcement to eliminate all points of contact.

B. The Contractor shall prepare written test procedures specifying the methods and equipment that will be used. Submit the proposed test method to the Engineer for approval a minimum of 30 days before the first concrete placement.

C. Isolation test methods may include measurements made between pipe and reinforcement for voltage difference, electrical resistance, or other parameters as required to prove electrical isolation. In no case shall an electrical resistance measurement made with a volt-ohm multimeter be accepted as a test procedure. In the event of a question regarding the electrical isolation of the pipe, the Engineer shall make the final determination.

D. Electrical isolation tests shall be conducted for each pipeline one day before placing concrete, the morning before concrete is placed, and immediately after the concrete is placed. The Engineer will witness the electrical isolation test conducted before the concrete is poured.

3.20 ELECTRICAL CONTINUITY TESTING OF PIPE WITH BONDED JOINTS

A. Conduct electrical continuity testing to demonstrate that all buried pipe joints (except insulated flanges) are either welded joints or have been electrically bonded across with No. 2 AWG stranded copper bond cables. The Contractor’s Cathodic Protection Technician shall conduct the tests. The Engineer will witness the electrical continuity tests. The Contractor shall demonstrate to the Engineer’s satisfaction that full electrical continuity has been achieved and shall make all required bond cable connections in the event that electrical continuity of the pipe is not achieved.

B. Perform electrical continuity tests at maximum spacings of 800 feet of pipe. Circulate a 12 volt electrical direct current through the pipeline. Use two pairs of test wires, one for current flow, one for voltage measurement. Measure the voltage difference developed by the DC current flow. Calculate the electrical resistance of the pipeline section in Ohms using Ohm's Law. The resistance test acceptance criterion is less than 150 percent of the calculated resistance value. The resistance value shall be calculated using the steel cross section area of the pipe, its length, and consideration for the joint bond cables at each bonded joint.

C. If other electrical continuity test methods are proposed, the Contractor shall prepare a written test procedure specifying the alternate method and equipment that will be used. A standard handheld digital multi-test meter's ohmmeter circuit (e.g. Fluke 87 or Beckman HD110) is not suitable for properly making these measurements. Submit in writing the alternate proposed test method to the Engineer for approval a minimum of 30 days before the pipe laying begins.

3.21 CATHODIC TEST STATION TESTING

A. Testing of Completed Welds: Exothermic weld connections shall be inspected by the Engineer prior to backfilling. At the Engineer's direction, tests to verify the soundness of the welds shall be conducted by the Contractor. Tests for this purpose shall consist of striking the weld nugget with a two pound hammer while steadily pulling on the wire. Note that the wire near the weld shall not be unnecessarily cold worked during installation or testing. Remove and reweld any welds that break loose or show signs of separating, as determined by the Engineer.
B. Wire Identification: Provide the Engineer 48 hours advance prior notice to verify that buried pipe lead wires and anode lead wires are properly identified with die stamped brass or stainless steel tags prior to backfilling the wires and the welded wire-to-pipe connections.

C. Pipe Test Wire Integrity Tests: After the pipe is buried, the pipe lead wire trenches are backfilled, and the cathodic test boxes are installed, the Engineer shall test each set of pipe lead wires for electrical continuity to the pipe. If more than twice the theoretical resistance of the pipe lead wire lengths is measured, the Contractor shall excavate the pipe and replace the pipe lead wires.

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3.22 CATHODIC PROTECTION SYSTEM ACTIVATION

A. Retain a NACE certified Level 2 Cathodic Protection Technician to perform the inspection testing. Perform tests under the direct supervision of a licensed professional Corrosion Engineer or a NACE certified Level 4 Cathodic Protection Specialist or NACE certified Corrosion Specialist. Supervision is defined in this specification as requiring a minimum eight hours of onsite field work at the start of the inspections to work with the Cathodic Protection Technician to plan, direct, and verify the testing procedures and to provide troubleshooting as required.

B. Provide a minimum of five days advance notice to the Engineer before the cathodic protection activation will be performed to allow for coordination and observance of these tests.

C. Before beginning each day of testing, calibrate portable copper sulfate reference electrodes with respect to a master reference copper sulfate reference electrode.

D. Measure CP Native Potentials (i.e. baseline pipe-to-soil potentials) at all Cathodic Test Stations prior to activating the cathodic protection system. Measure CP Native Potentials on both sides of all insulating flanges, monolithic insulators, dielectric unions, and at all CTS wires. Where two wires are attached to the same pipeline, measure and record the CP Native Potentials for both wires. If the potential measurements for the same pipeline differ by more than two millivolts, investigate the cause. See the previous paragraph titled “Pipe Test Wire Integrity Tests”.

E. At CTS constructed with buried copper/copper sulfate reference electrodes (i.e. stationary reference electrode”) measure CP Native Potentials of the pipeline using both the stationary reference electrode and a portable copper sulfate reference electrode before the CP system is activated.

F. Activate the cathodic protection system by energizing the rectifier(s) and setting their output(s) to the estimated output required.

G. Measure CP “On Potentials” at the same locations where CP “Native Potentials” were previously measured.

H. Measure all anode currents at anode junction boxes by measuring the voltage drop across the calibrated shunts provided. Calculate the corresponding amount of direct current flow using the shunt rating. Explicitly state the shunt rating on each data sheet.
I. Remeasure CP “On Potentials” at all CTS at least two weeks after the initial energization of the cathodic protection system to allow for the development of the cathodic polarization process.

J. Furnish all test results including all CP Potential readings, anode current readings, insulating flange test data, dates, and times. Reference all data to pipeline station numbers. Submit all data along with a letter report to the Engineer. The letter report shall include a description of the test methods, analysis of the data, and conclusions about the CP system’s effectiveness. Submit all data in spreadsheet format compatible with Microsoft Excel. Submit data in both hard copy and computer disk format.

3.23 ACCEPTANCE CRITERION FOR STEEL PIPE WITH DIELECTRIC COATING

A. The operation of the cathodic protection system shall be tested to ensure that all portions of the pipeline are provided a full level of corrosion protection. The standard used to evaluate the CP potential measurements shall be in accordance with only the 0.85 Volt criterion in NACE RP0169.

1. 0.85 VOLT CP ON POTENTIAL - A negative voltage of at least 0.85 volt as measured between the pipeline and a copper sulfate reference electrode contacting the soil immediately over or adjacent to the pipeline. Determination of this voltage is to be made with the cathodic protection current applied. Voltage drops must be considered for valid interpretation of this voltage measurement. To avoid anode gradient voltage drop errors (i.e. IR drop error), this criterion shall only be used at locations greater than 20 feet away from any galvanic anodes and greater than 200 feet away from any impressed current anodes.

3.24 ACCEPTANCE CRITERIA FOR STEEL PIPE WITHOUT A DIELECTRIC COATING

A. The operation of the cathodic protection system shall be tested to ensure that all portions of the pipeline are provided a full level of corrosion protection. The standards used to evaluate the CP potential measurements shall be in accordance with either of the two following NACE RP0169 criteria.

1. 0.85 VOLT CP ON POTENTIAL - A negative voltage of at least 0.85 volt as measured between the pipeline and a copper sulfate reference electrode contacting the soil immediately over or adjacent to the pipeline. Determination of this voltage is to be made with the cathodic protection current applied. Voltage drops must be considered for valid interpretation of this voltage measurement. To avoid anode gradient voltage drop errors (i.e. IR drop error), this criterion shall only be used at locations greater than 20 feet away from any galvanic anodes and greater than 200 feet away from any impressed current anodes.

2. 100 mV CP POLARIZATION SHIFT - A minimum polarization shift of 100 millivolts measured between the pipeline being protected from corrosion and a copper sulfate reference electrode contacting the soil immediately over or next to the pipeline. This minimum polarization shift shall be determined by interrupting all cathodic protection currents and measuring the polarization formation or decay. At the instant the cathodic protection current is interrupted (“instant off”), an immediate voltage shift will occur. The voltage reading just after the immediate shift shall be used as the base reading from which to calculate the polarization formation or decay.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section describes furnishing, installing, and testing equipment and incidentals required for monitoring and control of access into Water Authority buildings.

1.02 SYSTEM DESCRIPTION

A. PLC Intrusion System

1. If any door or hatch limit-switch transitions to the "open" state, an intrusion alarm signal shall be sent to the Master PLC and shall be logged by the system.

2. The alarm shall return to normal only when all the door limit switches are in the "closed" state.

B. Card Access System

1. Access to all Water Authority facilities shall be controlled by a card-access system. Entrants must provide a valid access card at the facility entrance card-reader to gain access to the facility.

2. The card-access system shall be a "stand-alone" system, with all access information contained within the station controller's internal memory. The station controller shall keep a log of all entries, which can be accessed by a laptop computer equipped with suitable software.

3. Conduits, raceways, wireways and doors shall be installed by the Contractor. The station access controller and all associated sensors shall be supplied and installed by others.

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Section 16050 General Electrical Requirements

B. Section 16160 Cabinets and Consoles

1.04 SUBMITTALS

A. Shop drawings for all material, equipment, apparatus, and other items as specified herein or required by the Engineer.

B. Product data for each limit switch specified. Include schematics of each device.

C. Manufacturer's installation instructions for limit switches.

PART 2 - MATERIALS

2.01 GENERAL REQUIREMENTS

A. Furnish all devices with heavy duty rating, designed for continuous industrial service. Provide intrusion alarm switches as manufactured by Square D, Sentrol, or equal.

B. Furnish materials and equipment that are UL approved.
C. Install all equipment in accordance with manufacturers instructions. Ensure that all cables and conduits are properly routed and secured.

2.02 PEDESTRIAN DOOR LIMIT SWITCH

A. Provide door limit switch for pedestrian doorways and the hatchways with one normally open and one normally closed contact. Locate switch mounting in the top of the door and frame such that switch transfers when door is open. Limit switch shall be Square D, C54B2 switch, Class 9007, with HA1 arm for pedestrian doorways and FA3 arm for hatchways.

<table>
<thead>
<tr>
<th>ALARM SWITCH</th>
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<tbody>
<tr>
<td>1. Tag No.</td>
<td>(see Plans)</td>
</tr>
<tr>
<td>2. Type</td>
<td>Mechanical Turret Head</td>
</tr>
<tr>
<td>3. Service</td>
<td>Door Entry Alarm</td>
</tr>
<tr>
<td>4. Material</td>
<td>Mfg. Std.</td>
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<tr>
<td>5. Connection</td>
<td>Mfg. Std.</td>
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<tr>
<td>6. Switch Type</td>
<td>Limit</td>
</tr>
<tr>
<td>7. Switch Contacts</td>
<td>SPDT</td>
</tr>
<tr>
<td>8. Contact Rating</td>
<td>Six amperes at 120-VAC</td>
</tr>
<tr>
<td>9. Electrical Class</td>
<td>NEMA 12</td>
</tr>
<tr>
<td>10. Electrical Conn.</td>
<td>Size 1/2 inch</td>
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</tbody>
</table>

2.03 OVERHEAD DOOR LIMIT SWITCH

A. Provide overhead door limit switch with one normally open and one normally closed contact. Use switch that comes complete with 36 inch stainless steel armored cable and mounting hardware. Mount at the base of the roll-up door so the floor-mounted switch transfers when door is opened. Limit switch shall be Sentrol Inc., Model 2207-AH, or equal.

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<td>Magnetic</td>
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<td>10. Electrical Conn.</td>
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</tr>
</tbody>
</table>
2.04 SYSTEM CONDUIT AND CABLE

A. Furnish and install conduit and cable for the PLC Intrusion System from each limit switch to PLC cabinet as indicated on the Plans.

B. Furnish and install conduit for the Card Access System from PLC cabinet, entry door, and controller mounting location as indicated on the Plans.

PART 3 - EXECUTION

3.01 EQUIPMENT INSTALLATION

A. Identification of Conductors and Cables: Use color coding of conductors and apply wire and cable marking tape to designate wires and cables in coordination with PLC system wiring diagrams and Section 16160, Cabinets and Consoles.

3.02 FIELD QUALITY CONTROL

A. Upon completing installation of the system, align, adjust, and balance the system and test. Correct deficiencies observed in testing. Replace malfunctioning or damaged items and retest until satisfactory performance and conditions are achieved.

B. Perform the following tests:

1. Continuity test for all conductors.

2. Functional test for each external contact to initiate the intrusion system for complete system performance check.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes the furnishing, installing, and testing of a fire alarm system as indicated on the Plans and as specified herein.

B. The work covered by this section shall include all labor, equipment, materials and services to design, furnish and install a complete fire alarm system of the zoned, non-coded general alarm type. Complete with all necessary hardware, software, and memory specifically tailored for this installation.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 16050 General Electrical Requirements

B. Section 16110 Raceways and Fittings

C. Section 16120 Wires and Cables

D. Section 16140 Wiring Devices

E. Section 16160 Cabinet and Consoles

F. Section 16450 Grounding

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS


B. UL, all applicable listings.

C. NFPA, all applicable code sections.

1.04 SUBMITTALS

A. Provide a list of all types of equipment, components, conduits, and wiring provided.

B. Provide a theory of operation of the system.

C. Provide manufacturer's printed product data, catalog cuts, and description of any special installation procedures; mark all submitted items on catalog pages with multiple items or components.

D. Provide samples of various items when requested.

E. Provide shop drawings as follows:
   1. Large scale drawing of the fire alarm control panel.
   2. Single line riser diagram showing all equipment and type, and number and size of all conductors.
1.05 MANUFACTURERS SERVICES

A. The manufacturer shall have a network of trained and experienced field support personnel that can provide product application assistance to include initial system start up, selection of hardware, software, communications and de-bugging through telephone consultation and on-site checkout. This support shall be available during the Water Authority’s normal working hours of Monday thru Friday, between 8:00 a.m. and 4:30 p.m.

B. The manufacturer shall conduct instruct Water Authority personnel in the operation and maintenance of the Fire Alarm System.

C. The manufacturer shall have a field service department staffed with experienced representatives with the capability of providing on site service.

1.06 QUALITY ASSURANCE

A. The Fire Alarm System manufacturer shall have a minimum of ten years of recent and continuous product history in the uninterruptible power system industry manufacturing Fire Alarm Systems that meet the requirement herein.

1.07 WARRANTY

A. All equipment shall be warranted by the manufacturer to be free from defects in materials, workmanship, and performance, to meet all performance specifications, and to operate without malfunction resulting directly or indirectly from material or workmanship for a period of two years from the date of installation.

B. The manufacturer shall offer a maintenance agreement providing the service of repair after the initial two-year warranty period has expired on all hardware. The maintenance agreement shall allow renewal on a yearly basis unless a 30 calendar day notice of cancellation prior to anniversary date is received. The initial contract cost shall be determined on a per unit cost that will negotiated by the Water Authority and the manufacturer.

C. The manufacturer shall provide a written guaranty to the continuing availability of all hardware, or its equivalent replacement, that was purchased by the Water Authority. This warranty shall extend for a period of five years. This shall include all power modules, battery modules, charger modules communication cards and chassis/back plane.

PART 2 – MATERIALS

2.01 MANUFACTURERS

A. Provide a fire alarm system manufactured by Edwards Systems Technology, or equal. If equipment of another manufacturer is submitted for approval as equal, the Contractor shall submit to the Engineer a description of the operating capabilities of the substituted equipment and any exceptions to the specified requirements. Final determination of compliance shall rest with the Engineer, who, at his discretion, may require proof of performance.

2.02 CIRCUITING AND CODING GUIDELINES

A. Each of the following types of alarm initiating devices shall be zone circuited as shown on the Plans, but shall be typically as follows:

1. Area smoke detectors: Provide detectors over each switchgear line-up, generator, and one over the MCC. Provide area detectors for each separate room.
2. Each of the following types of alarm sounding or notification devices shall be circuited as shown on the Plans but shall be typically as follows:

a. Alarm bell/strobes: Provide one alarm circuit(s), an audible and visual for each five alarm horn/strobes.

3. Each of the following types of remote equipment associated with the fire alarm system shall be provided with a single-pole double-throw control relay contact as shown on the drawings, but shall be typically as follows:

a. HVAC/fan systems: Provide one shutdown control relay contact for all fan systems.

2.03 FIRE ALARM SYSTEM SEQUENCE OF OPERATION

A. Operation of any alarm-initiating device shall automatically:

1. Sound all alarm signals throughout the building at the programmed evacuation rate.

2. Turn on all strobe lights throughout the building.

3. Sound the control panel's internal signal continuously.

4. Flash the system red common alarm LED.

5. Flash the red zone active LED for the circuit of alarm at the fire alarm control panel.

6. Start the reset-alarm silence disable timer to guarantee that alarm signals will sound for a minimum period of three minutes.

7. Start the automatic evacuation timer to guarantee the evacuation signals shall sound through the building if an operator is not present to cancel the automatic evacuation. The automatic evacuation period shall be set at five minutes.

8. Operate the alarm relay contact to initiate the transmission of an alarm indication to a telephone dialer that can call up to four telephones, cellular phones, or pagers.

9. Operate control relay contacts to shutdown all HVAC or fan units.

B. The entire fire alarm system wiring shall be electrically supervised to automatically detect and report trouble conditions to the fire alarm control panel. Any opens, grounds, or disarrangement of system wiring and shorts across alarm bell/strobe wiring shall automatically:

1. Sound an audible signal at the fire alarm control panel. The audible signal shall be capable of being silenced during the trouble condition.

2. Flash a zoned trouble LED to indicate the source of the wire trouble.

3. Operate two control relays; 1) contacts to initiate the transmission of a trouble indication to the dialed phone or cellular phone and 2) contacts to notify SCADA system of a trouble condition.

C. Provide interface with generator smoke and heat detectors. The fire alarm system shall trip the generator lockout relay and provide fire alarm indication to the Master PLC when fire is detected.
2.04 FIRE ALARM CONTROL PANEL

A. The fire alarm control panels shall be Edwards Systems Technology type LSS series and shall incorporate all control electronics, relays, and necessary modules and components in a surface mounted cabinet. The operating controls and zone/supervisory indicators shall be located behind locked door with viewing windows with keys made available only to authorized operating personnel. All control modules shall be labeled, and all zone locations shall be identified. The panel and door assembly shall be steel, with a white or red finish. The assembly shall contain a base panel, system power supply and battery charger with optional modules suitable to meet the requirements of these specifications.

B. The fire alarm system shall be provided with battery back-up capability. The batteries shall be of the sealed, lead-acid type and provide 24 hours of normal standby operation and five minutes of normal alarm operation at the end of the standby period. The batteries shall be supervised for placement and low voltage. It shall be possible to mount the batteries remote from the panel.

C. Base Panel, LSS4:

1. A base panel shall be provided with a central processor with a watchdog circuit for the fire alarm system. The base panel shall provide data communication to support expansion modules and remote annunciation, and shall supervise all modules for placement. The base panel shall provide common control indicators (normal, alarm, supervisory, trouble); common control switches (reset, alarm silence, trouble silence, and drill); four initiating device circuits each with a zone active LED, a zone trouble LED, and a disconnect switch; and two notification appliance circuits each with a zone status/trouble LED. Using only these controls in a prescribed sequence it shall be possible to test all system LEDs and program system operations. The base panel shall allow uploading and downloading of computer programs. The base panel shall define IDCs for verified smoke, non-verified, water flow or supervisory operation, and shall convert IDCs to Style D. Each IDC shall have a related open collector circuit capable of sinking up to 100 mA. NACs shall be programmable for audible (silenceable or non-silenceable) or visual operation. NACs may be circuited as Style Y or Z. Signal rates may be set to continuous, 120-bursts per minute, march time, Morse "U", or temporal. Alarm silence/reset inhibit and alarm silence cutoff shall be programmable for zero minutes to 99 minutes or disabled. AC brownout delay may be set to six hours.

2. The system shall be programmed for two-stage operation and enable an automatic evacuation timer at three minutes, five minutes, or ten minutes. Cancellation of the timer operation shall be by using a front panel control and this condition shall annunciate on the digital display. The base panel shall provide a set of form 'C' alarm contacts rated at 120 Vac at 2 A inductive, and the capability to plug in an auxiliary module for central station, remote station, municipal loop or proprietary type connections. It shall be possible to transmit supervisory and trouble signals separately from alarms. Common open collector’s circuits for alarm, supervisory, or trouble shall sink up to 100 mA each. The base panel shall provide power for optional modules and a total of 3.5 A at 24 Vdc for two signal circuits, auxiliary power (up to 2 A at 24 Vdc), and a four wire smoke source (up to .5 A at 24 Vdc). All circuits shall be power limited. The power supply shall provide automatic battery charging capability to charge up to 30 AH batteries. The base panel shall provide a digital display for reporting system status/conditions; alarm silence, trouble silence, drill active, ac power failure, battery trouble, power out trouble, ground fault, external trouble, communication trouble, and automatic evacuation timer canceled. The display shall support both user test and programming operations.

D. Zone Expansion Module, 4ZEXP and 8ZEXP: The initiating device circuit module(s) shall provide four or eight power limited, electronically supervised Style B circuits, monitoring for active (short) and trouble (open) conditions. It shall be possible to convert wiring to Style D. Maximum line resistance shall be 50 ohms. There shall be a disconnect switch and a zone active and trouble LEDs for each circuit. Each circuit shall have related open collector circuits capable of sinking up to 100 mA. Each circuit shall be
programmable for verified, non-verified, water flow or supervisory operation. The zone active LED shall flash red for alarm and yellow for supervisory. The trouble LED shall flash yellow for circuit faults and the disconnect condition. Provide one expansion module for the 2-A Pump Station Project.

E. Style D (Class A) Converter Module, 4CLA: The Style D converter module shall plug into the base panel or a zone expansion module to convert Style B circuit wiring to Style D for each of IDCs.

F. Notification Appliance Circuit Module, 4IAC: The IAC module shall provide four power limited, independently operable Style Y/Z circuits capable of providing up to 3.5 A at 24 Vdc each. Each circuit shall operate polarized, parallel-wired notification appliances and be electronically supervised for open and shorted circuits. Each circuit may be independently powered up to 3.5 A from distributed power from the same power source as the base unit. Each circuit shall have a status/trouble LED which shall turn on steady for circuit active and flash for circuit trouble. Provide a minimum of one Notification Appliance Circuit Module.

G. Auxiliary Relay Module, 4REXP: The relay module shall provide four independently programmable relays with form 'C' contacts rated at 30 Vdc, 2.0 A inductive at a .35-power factor. The relay module shall install on the base panel or on any IDC module. When installed on the base panel, it shall be possible to set one relay for common trouble operation and a second relay for common supervisory operation. The module shall be approved for central station and proprietary system interfaces. Provide one spare auxiliary relay module.

H. Power Supply Module, LSSPS: Auxiliary power supplies shall be power limited and provide up to 3.5 A at 24 Vdc regulated and filtered. It shall be possible to distribute all of this power to notification appliance circuits or provide up to 2 A for auxiliary purposes and the remainder for signals. The power supply shall provide automatic battery charging capability. It shall be possible to parallel the battery charger with the main power supply to charge up to 50 AH batteries or independently charge separate 30 AH batteries.

I. City Tie Module, MBPR (not included in remote FCF): The municipal/remote station module shall provide local energy and polarity reversal power limited circuits for city tie connections. The local energy master box output shall be 24 Vdc at 275 mA (14.5-ohm coil). There shall be three reverse polarity circuits to individually transmit alarm, trouble, and supervisory. The rating of each circuit shall be 24 Vdc, 7 mA with a maximum line impedance of 50 ohms.

J. Conventional Fire Alarm Initiating Devices - General: All initiating devices shall be UL Listed for Fire Protective Service. All initiating devices shall be of the same manufacturer as the Fire Alarm Control Panel specified to assure absolute compatibility between the devices and the control panels, and to assure that the application of the initiating devices is done in accordance with the single manufacturer’s instructions. Any devices that do not meet the above requirements, and are submitted for use shall show written proof of compatibility for the purpose intended. Such proof shall be in the form of documentation from all manufacturers that clearly states that the equipment (as submitted) is 100 percent compatible with each other for the purpose intended.

K. Notification Appliances - General: All appliances shall be UL listed for Fire Protective Service. All strobe appliances or combination appliances with strobes shall be capable of providing the “Equivalent Facilitation” which is allowed under the Americans with Disabilities Act Accessibilities Guidelines, and shall be UL 1971, and ULC S526 Listed. All appliances shall be designed to interface with the Fire Alarm Control Panel specified to assure absolute compatibility between the appliances and the control panels, and to insure that the application of the appliances are done in accordance with the Panel manufacturers’ instructions. Any appliances that do not meet the above requirements, and are submitted for use shall show written proof of their compatibility for the purposes intended. Such proof shall be in the form of documentation from all manufacturers which clearly states that their equipment (as submitted) are 100 percent compatible with each other for the purposes intended.
L. Ancillary Devices General: Ancillary devices submitted for use must have written proof of their compatibility for the purpose intended. Such proof shall be in the form of documentation from all manufacturers that clearly states that their equipment (as submitted) is 100 percent compatible with each other for the purpose intended.

M. Remote Relays: Provide remote control relays connected to supervised ancillary circuits for control of fans, dampers, door releases, etc. Relay contact ratings shall be SPDT and rated for 5 amperes at 115 Vac. A red LED shall indicate the relay is energized. SCADA and Dialer relays shall be DIN Rail mounted in CP1.

N. Automatic Voice/Pager Dialer: Provide an Automatic Voice/Pager Dialer for direct, immediate notification of emergency situations using the regular telephone line. When a smoke detector is activated the Automatic Voice/Pager dialer shall call any combination of up to eight telephones, cellular phones or pagers, and shall deliver a customized, recorded message to phones or programmable DTMF tones for pagers. The unit shall accept up to four input zones and play a different Outgoing Message for each zone. The unit shall notify designated on call personnel of the emergency so they can respond immediately. The Voice Pager unit shall have listen Verification allowing two-way communication. EEPROM memory retains programming phone numbers and voice messages in the event of power failure. Provide customized, recorded messages as designated by the Engineer. Unit shall include the PB12P power pack for standby power in combination with the 120-vac input with the AC/DC adapter. Provide unit as manufactured by United Security Products model AD-2000, or approved equal. Dialer shall be mounted in communication cabinet.

PART 3 – EXECUTION

3.01 QUALIFICATIONS OF INSTALLER

A. The system installer shall be an experienced in the installation of Fire Alarm Panels, and shall be located in the San Diego County Area. Submit a list of at least ten projects installed by the system installer along with names and phone numbers of persons to contact regarding the installations. The system installer shall provide 24-hour on-call service and provide to the Water Authority a Service Agreement that includes Testing and Inspecting of all equipment for proper operation for a period of two years.

3.02 INSTALLATION

A. The entire system shall be installed in a workmanlike manner, in accordance with approved manufacturer's wiring diagram. Furnish all conduit, wiring, outlet boxes, junction boxes, cabinets and similar devices necessary for the complete installation. All wiring shall be of the type recommended by the manufacturer, approved by the local Fire Department, if applicable, approved by the Engineer, and installed in rigid, threaded conduit throughout.

B. All penetration of floor slabs and firewalls shall be fire stopped in accordance with all local fire codes.

C. End of Line Resistors shall be furnished as required for mounting as directed by the manufacturer.

D. All wiring shall be color coded throughout, to National Electrical Code standards.

E. The system shall be arranged to receive power from one three wire 120 Vac, 15-A supply. All low voltage operation shall be provided from the fire alarm control panel.

3.03 FIELD QUALITY CONTROL

A. The system shall be installed and fully tested under the supervision of a trained manufacturer's representative. The system shall be demonstrated to perform all of the functions as specified. Reports of any field testing during installation shall be forwarded to the Engineer.
B. Each individual system operation on a circuit-by-circuit basis shall be tested for its complete operation. The procedure for testing the entire fire alarm system shall be set forth with the consent of the code enforcement official (if applicable), the Engineer, and the manufacturer.

3.04 DOCUMENTATION AND TRAINING

A. Compile and submit three complete manuals on the completed system to include operating and maintenance instruction, catalog cuts of all equipment and components, as-built wiring diagrams, and a manufacturer's suggested spare parts list.

B. Provide the services of the manufacturer's trained representative for a period of four hours to instruct the Water Authority's designated personnel on the operation and maintenance of the entire system.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes furnishing, installing, and testing a fiber optic cable system within a buried high density polyethylene duct and all appurtenant apparatus as specified herein and as shown on the Plans.

B. Provide all tools, supplies, materials, equipment, and all labor necessary for furnishing, constructing and installing a complete fiber optic cable system.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02200 Earthwork

1.03 REFERENCE SPECIFICATION, CODES, AND STANDARDS

A. American Society for Testing and Materials
   D1248 Specification for Polyethylene Plastics Molding and Extrusion Materials.
   D1603 Test Method for Carbon Black in Olefin Plastics.
   D2239 Specification for Polyethylene Plastic Pipe Based on Controlled Inside Diameter.
   D3349 Test Method for Absorption Coefficient of Carbon Black Pigmented Ethylene Plastic Film.

B. Plastics Pipe Institute
   PPI Handbook of Polyethylene Pipe

C. National Electrical Manufacturers Association
   TCB2-2000 NEMA Guidelines for the Selection and Installation of Underground Nonmetallic Duct

D. National Electrical Contractors Association
   NECA-2004 Installing and Testing Fiber Optic Cables

1.04 SUBMITTALS

A. Catalog data on the fiber optic cable, HDPE duct, pull boxes, connectors, cable lubricant, duct sealant, closures, pull rope, enclosures, identification tape, mounting hardware, pulling equipment, testing equipment, and splicing hardware and equipment.

B. Detailed bill of materials.

C. Written procedure on the splice method for cable, duct, and cable pull rope.

D. Written procedure on the installation methods that will be used when pulling the fiber optic cable through duct as applicable to this installation. Include a reference to each pullbox station where cable, figure-eighting and pulling equipment will be staged during each pull.
E. Written procedure outlining the steps and methods that will be used to test the cable during and after installation. Include a sample copy of each test form that will be used in the test procedure.

F. Cable installation procedure outlining the methods that will be used for duct extruded over a fiber optic cable. Identify steps that will be taken to ensure that the cable is not damaged during the extrusion process or the installation.

G. Complete manufacturer test results for each cable reel stating conformance to the requirements specified herein. Manufacturer test data shall include Optical Time Domain Reflectometer traces for each fiber of each reel taken at 1,300 nm wavelengths and 1,550 nm wavelengths.

H. Cable pull calculations for each duct run.

I. Plans indicating the location of all splices and pull boxes with references to pipeline station numbers.

J. Fiber optic cable and installation qualifications as specified herein.

K. Written statements of compatibility from all manufacturers that state that their product is compatible with the other manufacturer's products used to furnish and install the fiber optic cable system, i.e., duct manufacturer's compatibility with pull rope, cable manufacturer's compatibility with splice trays.

L. Provide a log of duct markings, pull box locations and duct splices. The log will be used to calculate distances between pull boxes.

M. Duct installation procedure including provisions to maintain line and grade in conformance with the detail drawings.

1.05 CONTRACTOR QUALIFICATIONS

A. Use qualified personnel, possessing the necessary equipment and having experience in similar installations. Evidence of qualification shall include the following:

1. Written evidence that the Contractor has a minimum of three consecutive years' recent experience with all aspects of the fiber optic cable system as specified, including the installation of conduit and pull boxes, pulling of fiber optic cable in conduit, splicing and testing of fiber optics, and the installation and testing of all other components of the fiber optic cable system. Such experience shall include a minimum of three projects with installation and testing of no less than 5,000 feet of continuous fiber optic cable. Retain specialty workers or subcontractors meeting this experience requirement.

2. Written evidence that the manufacturer of the fiber optic cable has manufactured and provided fiber optic cable equal to the cable specified herein and installed under similar conditions for a minimum of five consecutive years.

3. Written evidence that the proposed fiber optic cable is compliant with all requirements of both Bellcore TR-TSY-000020 and REA PE-90 certifications.

4. Provide a list of completed installations similar to this project including the name, address, phone number, and fax number of the owner, the name of the project, type of cable with model number, and the date of completion. Provide separate lists for the contractor, supplier, and cable manufacturer.

5. The name and qualifications of the supervisory personnel that will be directly responsible for the installation of the fiber optic system.
1.06 QUALITY ASSURANCE TESTING

A. Quality assurance testing will be performed by the installation contractor, in accordance with all applicable sections of this specification, and the results shall be submitted to the Engineer for approval.

B. Field tests shall be performed on each fiber. All fibers will be tested for breaks, abnormalities, and overall attenuation characteristics to ensure that the db loss at each splice point and test location is in conformance with the requirements specified herein.

C. After delivery to the site, and before the cable is installed, an end-to-end OTDR trace for each fiber at both 1,300 nm and 1,550 nm wavelengths, using the proper index of refraction for that fiber shall be performed. These traces shall identify the total optical length. An average optical attenuation measurement (Db/km) shall be made for each fiber at both 1,300 nm and 1,550 nm wavelengths with an OTDR. Each measurement will be captured on a trace. Any cable delivered containing fiber that does not meet the minimum Db/km loss specified herein or shows macro or micro bend damage shall be rejected.

D. A test shall be performed of each optical fiber end-to-end for each installed span after cable installation and after any intermediate (non-terminating) splicing is completed. For each fiber, an end to end OTDR trace shall be made at both 1,300 nm and 1,550 nm wavelengths and shall show total optical length. Testing will be conducted from both ends of the fiber. During testing, the Contractor shall use an acceptable power meter to measure and record the transmitted power for each test of each fiber.

E. For each installed optical fiber, the following measurements shall not be exceeded:

\[
\text{Measured loss less than: } (0.0040)L + (0.15)N + 1.0\text{dB (for 1300-nm)}
\]

\[
\text{Measured loss less than: } (0.0030)L + (0.15)N + 1.0\text{dB (for 1550-nm)}
\]

Where:  
\(L\) = Optical length of the fiber in meters  
\(N\) = Number of non-terminating splices in the cable

F. Any installed fiber optic cables containing one or more fibers not meeting the specified insertion loss above shall not be accepted and shall be repaired or replaced.

G. Splice testing for each fiber splice shall be conducted. The splice test shall include bi-directional measurement using an OTDR. Remake and retest splices that exceed the specified 0.15-dB loss figure until compliance is achieved.

H. Any test failing to meet the specified requirements shall be deemed non-compliant with the specifications. The Contractor shall repair or replace all deficient materials and equipment. The Contractor shall be backcharged the cost of retesting failing test. Such backcharges shall be deducted from the Contractor’s progress payments.

PART 2 - MATERIALS

2.01 FIBER OPTIC CABLE

A. The fiber optic cable shall be a single mode, dual window cable suitable for use with both 1,300 nm and 1,550 nm transmission equipment. The cable shall consist of twelve fibers, with a maximum number of six fibers per buffer tube. The cable sheathing shall be medium density polyethylene. The cable shall utilize water-blocking gel and be all dielectric. The cable shall be fully compliant to Bellcore TR-TSY-000020 and REA PE-90 standards.
B. Each fiber shall consist of an 8.3 micron core with a 125 micron cladding and a coating diameter minimum of 250 microns.

C. The maximum individual fiber loss shall be 0.4 db/km at 1,310 nm and 0.3 db/km at 1,550 nm.

D. Each fiber shall be individually color coded. Color coding which uses only the color of tube or buffer as a designation is unacceptable.

E. Dispersion shall be less than or equal to 3 ps/nm/km at 1,310 nm, 20 nm, and 18 ps/nm km at 1,550 nm. Cut-off wavelength shall be 1,130 nm to 1,290 nm. The zero dispersion wavelength shall be 1,310 nm. Fiber noncircularity shall be 0.2 percent. Operating temperature shall be minus 40 degrees C to 70 degrees C.

F. Crush resistance shall be 220 N/cm minimum.

G. The fiber optic cable shall have a tensile load rating of 600 pounds minimum.

H. The outer jackets of the cable shall be continuous, free from holes, splits, blisters, or inclusions. The same requirement holds for any inner jackets within a given cable structure as well as fiber coatings.

I. Materials used for the fiber optic cable shall present no environmental or toxicological hazards as defined by current industry standards and shall comply with OSHA and EPA standards and applicable federal or state laws or regulations.

J. The outer jacket material shall be MDPE. The color of the jacket shall be black in accordance with ASTM D1248 and contain a suitable antioxidant substance. The carbon black used shall be furnace-type conforming to the designation No. 110 in ASTM D1765. The carbon black content on the jacket material when measured in accordance with ASTM D1603 shall be 2.6 percent 0.25 percent by weight. The light absorption coefficient of the jacket material shall be at least 400 when measured at a wavelength of 375 nm per ASTM D3349.

K. Outer polyethylene jacket materials shall meet the Fiber Optic Test Procedures tensile strength and elongation minimum requirements for unaged and aged samples as follows: tensile strengths at break shall be no less than 2,700 psi unaged and 75 percent aged. Elongation at rupture shall be no less than 400 percent unaged and 375 percent aged.

L. The outer jacket shall be permanently marked every two feet with consecutive numbering at each mark for the entire length. Markings shall be stamped and white in color.

M. The outer jacket shall be permanently marked at regular intervals with the name of the manufacturer, date manufactured, product identification code, and standards codes when appropriate.

N. The cable jacket shrinkage test measures the shrinkage or expansion of a cable jacket exposed to temperature aging for a specified period of time. Maximum shrinkage shall be less than 5 percent for each specimen tested. The test procedure is described in EIA-RS-455, FOTP-86.

O. All of the fiber optic cable shall be supplied from one manufacturer and shall be consistent throughout the entire project.

P. The fiber optic cable shall be the loose tube gel filled type as manufactured by Corning, or equal.

Q. All fiber optic cable shall be purchased in continuous segments no less than 4,000 meters (13,120 feet), plus or minus 5 percent. If specific project design or construction conditions warrant deviations from this requirement, identify such and propose their alternative(s) during the submittal phase of the project.
2.02 FIBER OPTIC SPLICE TRAYS

A. Fiber optic splices shall be made by the fusion process with a loss no greater than 0.15 db per splice. The splice trays shall be consistent and suitable for use with the type of cable provided.

2.03 FIBER OPTIC SPLICE CLOSURE ASSEMBLY

A. Install fiber optic splices in pull boxes. Splices shall be made in a re-enterable splice closure assembly with removable splice organizer trays. The splice closure assembly shall consist of individually accessible splice trays and an inner and outer closure. Provide Coyote Closures, Raychem FOSC 400 B2 or B4, or equal.

2.04 FIBER OPTIC CABLE ENCLOSURES

A. Fiber optic cable enclosures shall be as defined in Section 16160, part 2.02, Communications Cabinet.

2.05 HIGH-DENSITY POLYETHYLENE DUCT

A. HDPE duct shall be SIDR-7 with a minimum inside diameter of two inches, or as shown on Plans, conforming to ASTM D2239. Provide HDPE duct marked by the manufacturer every two feet with consecutive numbering at each mark for the entire length of the duct. The HDPE ducting process shall not affect the cable warranty. Perform an OTDR trace at 1,300 nm and 1,550 nm before and after the ducting process, if the duct is extruded over the cable. HPDE duct shall be as manufactured by Integral Corp., or equal.

B. HDPE duct splices shall utilize the manufacturer's recommended threaded, corrosion-resistant, screwed couplings. Couplings shall be made water-tight using standard electrical-grade heat-shrink sleeve.

2.06 SEALED BUSHINGS

A. Furnish and install sealed bushings at the ends of all cable-in-duct. Sealed bushings shall be mechanically tightened, split inner-duct plug, as manufactured by Jack Moon Ltd., Arnco, or equal.

B. Furnish and install sealed bushings for conduit entering pull boxes. Use mechanically expanding bushings as manufactured by Jack Moon Ltd., George Ingraham, or equal.

2.07 LUBRICANT

A. Furnish cable-pulling lubricant in an amount necessary to meet a minimum application rate of one gallon per 1000 feet. The cable lubricant shall be compatible for use within the duct and shall facilitate fiber optic cable pulling. The cable lubricant shall be Integral LUBADUK, or equal.

2.08 FIBER OPTIC CABLE PULL BOXES

A. Provide 36 inch long by 24 inches wide by 36 inches in diameter pull boxes for all locations, except provide 48 inches long by 30 inches wide by 36 inches in diameter pull boxes at location of future flow control facilities. Measurements represent interior clear distances.

B. Provide traffic bearing precast concrete pull boxes designed for H-20 bridge loading. Covers for pull boxes shall be galvanized steel. Grind center of pull box cover to create a 1-5/8 inch by 16 inch by 1/16-inch recess area for a cast steel name plate. Weld cast steel nameplate continuously around the outside edge, grind weld bead smooth, and cold galvanize nameplate. The nameplate shall read "SDCWA COMCBL" with square block capital letters. The letters shall be a minimum of 1-1/4 inches tall, raised 1/16 inches, with spacing between letters at 1/2 inch. A blank space shall be left at both ends from the "SDCWA COMCBL" wording. Covers shall have locking devices and form a watertight seal to prevent
surface water from entering the box. Knockouts in the wall shall permit underground conduit penetrations. Accessories shall include angle iron and pulling eyes. Provide Brooks, Associated Concrete Products, or equal.

2.09 CABLE IDENTIFICATION TAPE

A. Cable identification tape shall be a plastic coated metallic orange tape not less than six inches in width. The tape shall have a continuous legend reading "CAUTION BURIED FIBER OPTIC CABLE" in black lettering. Tape splices shall be per tape manufacturer's recommendations to ensure tape continuity for locating purposes. The tape shall be Panduit, Terra Tape, Brady and Blackburns, or equal.

B. A tracer wire, of stranded 12 ga. THHN, shall be pulled with the fiber optic cable during any buried-conduit installation that does not have a tracer wire installed. Tracer wire shall be neatly coiled in each pull box, with a minimum of 20 feet of excess wire for each direction of the buried conduit.

2.10 CABLE PULL ROPE

A. The cable pull rope shall be constructed of a solid braid polyethylene jacket with a polyester core. The duct manufacturer shall certify that the cable pull rope is compatible for use with pulling fiber optic cable.

B. The cable pull rope shall be preinstalled by the duct manufacturer before the duct is laid.

PART 3 - EXECUTION

3.01 CABLE PACKAGING

A. Package the cable on a reel with inner hub diameter greater than the recommended minimum bending diameter of the cable. The anchor holes on the reels shall admit a 63.5 mm (2 1/2 inch) diameter spindle without binding. The package shall be sturdy enough to endure reasonable handling in the process of shipping and storage.

B. Securely attach tags, or clearly and permanently stencil or label each reel, with the following information: customer order number, customer job number, customer reel number, termination, ship date, manufacturer's name, factory reel number, manufacturer's cable code (type and fiber count), length of cable, weight of cable and reel, and defect tag.

C. Seal the ends of all cable to prevent the escape of filling compound and to prevent the entry of moisture during shipping, handling, storage, and installation.

3.02 LOCATION OF FACILITIES

A. The Plans diagrammatically indicate the desired location and arrangement of pull boxes, cable runs, and other elements of the fiber optic cable system. Determine exact locations in the field based on the size and arrangement of specified materials, capabilities of installation equipment, finished elevations, and allowable cable pulling tensions and obstructions. Stake pull box locations in the field and obtain Engineer’s written approval prior to installation.

3.03 SWIVEL AND GRIPS

A. Insert a reliable nonfreezing type of swivel between the pulling line and the cable pulling grip to prevent twisting under strain. Equip the swivel with shear or tension pins with a breaking strength of 600 pounds. Do not pull cable without a breakaway swivel.

B. Use the manufacturers approved method to grip the cable during pulling operations. Include a copy of the manufacturers approved method to grip the cable during pulling operations with the cable submittal.
3.04 DUCT INSTALLATION

A. Install the duct in trenches as shown on the Plans and backfilled with imported sand or crushed rock conforming to Section 02200. Place the identification tape 18 inches directly above the top of the duct.

B. For duct that will not be immediately used, seal duct at both ends to prevent moisture from entering.

C. For change in direction exceeding 45 degrees in either the horizontal or vertical direction, do not install duct without a pull box or without utilizing a bend radius less than 20 feet. Duct must be installed as straight as possible, with no side to side or top to bottom bending.

D. At duct splicing locations provide sufficient cable pull rope beyond the ends of the duct to allow for splicing of cable pull rope.

E. Use manufacturer approved methods and materials to splice the cable pull rope and duct. Spliced sections of rope are to withstand the maximum pull tension (600 pounds) available by the pulling equipment used without damaging the integrity of the duct while pulling.

3.05 PULL BOX LOCATIONS AND INSTALLATION

A. Install fiber optic cable pull boxes in accordance with the following:

1. The maximum distance between any two pull boxes shall not exceed 3,000 feet, unless otherwise shown on the Plans, or approved in writing by the Engineer.

2. Install additional pull boxes at locations where the cable pulling tension approaches, but does not exceed 600 pounds.

3. Install pull boxes at each Flow Control Facility or other designated facility, as shown on the Plans.

4. Install pull boxes on one side of tunneled street crossings. Install pull boxes on both sides of tunnel crossings which require more than 180 degrees of duct bends to account for elevation differences or route adjustments.

5. Install pull boxes on both sides of tunnels that are longer than 3,000 feet.

6. Contractor shall install new pull boxes on each side of any encasement, unless there is an existing pull box within 200 feet of the end of the encasement.

B. Install sealed bushings where duct enters the pull box.

C. Inside the installed pull box, paint the distance in feet to the next pull box or opening as determined from log of duct markings. Use orange paint and two inch high stenciled numbers. Paint numbers three inches above every duct opening.

D. Place the bottom of the pull box firmly on a six inch thick bed of 3/4 inch crushed rock extending six inches beyond the outside edges of the pull box.

3.06 FIBER OPTIC CABLE INSTALLATION

A. Install cable in HDPE duct in accordance with the manufacturer's recommendations. Do not allow cable to be bent or twisted into a radius less than the manufacturer's minimum bend radius. All installation equipment and methods shall be reviewed and approved by the Engineer prior to installation. Include a copy of the manufacturers recommended procedure for cable installation with the cable submittal. Install cables in accordance with the manufacturers recommendations. All cable pulls shall be witnessed by the Engineer.
B. Clean and test the duct prior to installing the cable. Clean the duct by passing a cleaning assembly through the duct, consisting of a flexible steel or rubber slug, followed by a wire brush. Repeat this operation if necessary to ensure that all construction debris has been removed from the duct. After cleaning the duct, perform a clearance test with a mandrel. Pass through the duct a rigid mandrel specifically designed for proving duct. Size the mandrel in accordance with NECA-2004 and NEMA TCB2-2000 guidelines. Pulling tension of mandrel is not to exceed 600 pounds and rope must not damage duct. Remove foreign materials, earth, sand, and gravel from the duct before the duct is lubricated. The Engineer shall be present to observe and approve all duct cleaning and testing.

C. Install the cable using a hydraulic capstan or winch, equipped with a recording running line dynamometer graph to measure and record the pulling tension, as manufactured by A.B. Chance Co., Evergreen Co., T.A. Pelsue Co., or equal. Use pulling equipment with "slip-load" capability to allow the winch to maintain a constant pulling force without taking up the winch line. Use the pulling equipment equipped with a hydraulic bypass set with a maximum tension of 600 pounds. If at any time the tension reaches 600 pounds during the pulling operation, discontinue the pull and notify the Engineer.

D. Connect and activate the recording graph before any pulling has begun. Run the graph continuously throughout the pulling operation. At the end of each pull, sign and date the graph and record the reel number. Provide a written explanation for any abnormality in a graph of a cable reel pull. Note all starts and stops on the graph with a separate written explanation for each interruption. Submit graphs at the end of each pull run.

E. Calibrate the pulling equipment before each pull. Do not make adjustments to the hydraulic system, gauges, or graph recorders after calibration.

F. Where practical, attach a rubber swab ahead of the cable to aid in dispersing the pulling lubricant evenly through the duct. Pour or pump lubricant into the end of the duct or conduit at the feed location prior to inserting cable. If the duct is open at intermediate locations, apply the appropriate proportion of lubricant at each opening. As the cable is being pulled, pour lubricant into the duct at the feed location and at each intermediate location or pull hole. Station workmen at each intermediate location as required. After cable pulling, remove excess lubricant that has collected in the manholes or buildings and clean the surrounding area. Add lubricant in accordance with cable manufacturers standard installation practices.

G. Position the cable reel at the feed vault in alignment with the duct and in such a position that the cable can be passed from the top of the reel in a long, smooth bend into the duct system. The use of a cable feeder is required.

H. Place a marker, consisting of several turns of friction tape on the pulling line, 20 feet from the end of the line. Use this marker to indicate when the cable is about to enter the pull box. When the marker on the pulling line arrives at the pull box, slow the pulling operation until the cable enters the pull box, and then discontinue. Pull sufficient slack by hand. Leave a minimum of 100 feet of cable slack in the pull boxes, measured from the centerline of the pull box. Support the cable on porcelain saddles attached to the inside wall of the pull boxes. Secure the cable to the porcelain saddles with cable tie wraps.

I. If backfeeding is required, remove the cable from the reel and place the cable in a figure eight pattern. Use protection covering over the ground for laying out the cable. Carefully handle and protect the cable to prevent damage. When pulling is ready to resume, hand feed cable into the duct system and follow the same pulling procedures.

J. If the pulling operation cannot be completed because of darkness, weather, equipment breakdown, etc., do not leave the cable exposed or unattended.

K. Supply all bull wheels, blocks, split wheels, cable feeders, and necessary equipment required to provide a clean and safe operation. Do not allow the cable to travel over any wheel or block that has a radius less than the minimum radius allowed by the cable manufacturer.
L. Minimize the use of snatch blocks and rollers to guide the cable into the duct at the feed manhole. Feed cable by hand into the feed manhole and duct without the use of rollers wherever possible. Tend the cable reel at all times and turn by hand to provide the required cable slack. Do not allow the cable tension to turn the cable reel. Place a rim roller, with a wheel radius greater than the minimum cable bending radius, at the manhole or vault opening to prevent the cable from dragging on the manhole rim or steps.

M. Conduct a thorough visual inspection for flaws, breaks, or abrasions in the cable sheath as the cable leaves the reel. Monitor the pulling speed to permit this inspection. Damage to the sheath or finish of the cable shall be sufficient cause for rejecting the cable. Replace cable damaged in any way during installation. All damaged cable shall be inspected by the Engineer before installation is continued.

N. Do not exceed a cable pulling tension of 600 pounds. During the pulling process, if any excessive strain develops, discontinue the pulling operation and notify the Engineer. Do not continue cable installation until the difficulty has been determined and corrective action taken.

O. The cable pulling operation shall be stopped by the Engineer if, at any time, the cable pulling procedure or the equipment used do not comply with the requirements specified herein.

3.07 SPLICE LOCATIONS

A. Minimize non-terminating (field) splices. A goal of no more than one field splice per 20,000 feet of installed cable will be pursued by the Contractor. Splice locations described here are exclusive of repair splices specified herein.

B. Install splices in splice tray organizers specifically designed for the type of splice being used. Place a heat shrink protection sleeve over the splice prior to placing the splice in the tray.

3.08 CABLE DAMAGE DURING INSTALLATION

A. If the cable becomes damaged during installation, discontinue the operations and notify the Engineer immediately. The Engineer will determine whether to replace the entire reel of cable or to install a splice at the damaged section. Determination for replacement of cable will be based on exceeding 600 pounds of pull, failure of attenuation test, or damage to cable jacket.

B. If the Engineer determines that the entire reel of cable needs to be replaced, begin the installation at the last designated splice point. The damaged cable between these points shall be removed from the duct, coiled, tagged, and removed from the jobsite.

C. If the Engineer determines that a splice needs to be installed at the damaged point, carefully excavate from the damaged point a distance along the cable as directed by the Engineer and expose the cable. Install a pull box at this point. A minimum of 50 feet on both ends of the cable (100 feet total) shall be coiled in the pull box. For any section of fiber cable between two terminations, no more than two repair splices will be allowed. If the Contractor has already performed two repair splices between pre-defined splice locations, and the cable is damaged a third time, replace the entire reel of damaged cable with a new reel.

3.09 DUCT INSTALLATION AT FLOW CONTROL FACILITIES

A. Where shown on the Plans, install a three-inch diameter, HDPE duct run between the pull box and the Flow Control Facility. Place the duct at a minimum depth of 36 inches. Backfill material and placement shall be in accordance with Section 02200. Backfill material within a zone between the bottom of the trench and to a point six inches above the top of the duct using imported sand or crushed rock. Backfill material from six inches above the top of the duct to finished grade using native earth backfill. Place the identification tape eighteen inches below finished grade.
B. The duct entrance into the Flow Control Facility shall be through a four inch diameter wall core at a location directed by the Engineer. Install a fiber optic cable closure assembly above the wall core as shown on the Plans. Permanently mount the enclosure to the interior wall of the facility, as recommended by the manufacturer. Provide a duct connection between the closure assembly and the wall core. Do not exceed the minimum bend radius restriction.

C. Provide water-tight entrances into the pull box, junction box and wall core, as well as duct fittings.

D. For pull box locations shown on the Plans for future Flow Control Facilities, provide 1,300 feet of cable coiled inside the pull box.

3.10 MARKER POST

A. Install a marker post at each pull box consisting of a concrete filled steel post as shown on the Plans. Paint the post with a safety yellow color high-gloss enamel and attach an underground utility warning decal.

3.11 CABLE MANUFACTURER SUPERVISION AND CERTIFICATION

A. Retain a qualified representative of the cable manufacturer to be present during the installation of the first complete reel of cable.

B. Cable manufacturer representative shall submit written certification to the Engineer that the Contractor has followed standard industry procedures and the requirements specified herein for the installation of the fiber optic cable.

3.12 REMOVAL, STORAGE, AND REINSTALLATION OF FIBER OPTIC CABLE

A. Before removal of any fiber optic cable, the Contractor shall perform an OTDR test of the cable to be removed. This test shall include all individual fibers, and shall be performed from both directions, at both 1300 and 1550-nm wavelengths. These tests shall be witnessed by the Water Authority representatives, and the results shall be tabulated and presented to the Engineer for review before the cable is removed.

B. The Contractor shall protect the fiber optic cable during the removal and storage process, using a method approved by the Engineer.

C. The removed cable shall be reinstalled in accordance with all provisions of this specification for the installation of new fiber optic cable. After reinstallation, the Contractor shall perform an OTDR test of the portion of the cable that was removed. This test shall include all individual fibers, and shall be performed from both directions, at both 1300 and 1550-nm wavelengths. These tests shall be witnessed by the Water Authority representatives, and the results shall be tabulated and presented to the Engineer for review before the cable reinstallation is accepted by the Water Authority.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes furnishing, installing, and testing the electrical control equipment and miscellaneous electrical equipment, including device enclosures for electrical equipment as indicated on the Plans and as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 16050 General Electrical Requirements

1.03 REFERENCE SPECIFICATION, CODES, AND STANDARDS

A. Underwriter's Laboratories, Inc.
   UL-508 Electric Industrial Control Equipment.

B. National Electrical Manufacturers Association
   250 Enclosures for Electrical Equipment.

C. National Fire Protection Association

D. California Electric Code.

1.04 SUBMITTALS

A. Manufacturer’s complete product specification and brochures, including wiring diagrams. Each submittal shall reference applicable specification sections.

PART 2 - MATERIALS

2.01 GENERAL

A. Install equipment inside a NEMA 1 enclosure in dry areas, a NEMA 12 enclosures in damp areas, and a NEMA 4 for outdoor or wet areas.

B. The valve-actuator disconnect box shall be a six inch by six inch by four inch NEMA 4 PVC enclosure, with a gasketed lid, manufactured by Carlon, or approved equal. The top of the box, where practical, shall be at the centerline of the pipe, but in no case less than two feet above finished floor level.

2.02 STEEL SUPPORT CHANNEL

A. Provide steel support channel and accessories that are hot-dipped galvanized after fabrication as specified or as indicated on the Plans.

B. Support channel and associated fittings shall be manufactured by: Unistrut Corp., Wayne, MI; Power-Strut, Warren, OH; B-Line Systems, Inc., Highlands, IL, or approved equal.
2.03 HANDHOLES

A. Provide Composolite underground handhole enclosures as manufactured by Quazite Corporation, or equal. Enclosures and cover shall be concrete gray color and rated for no less than 5,000 lb. over a ten-inch x ten-inch area and be designed and tested to temperatures of minus 50 degrees F. Use material with minimum compressive strength 11,000 psi. Provide covers with a minimum coefficient of friction of 0.5.

B. Furnish boxes that are stackable for extra depth.

C. Size handholes per requirements of the NEC for number of conduits and cables entering handhole.

D. Provide covers with "Electric" or "Communications" logo corresponding to the installed system.

E. Provide handholes with stainless steel Penta-head bolts.

F. Provide "PC" style (stackable) service box assemblies.

2.04 CONTROL STATIONS

A. Provide heavy-duty, oil-tight pushbutton and selector switch control stations with momentary or maintained contacts as indicated or specified for starting and stopping of equipment. Minimum contact rating is ten-amperes. Pushbuttons and selector switches shall be manufactured by Cutler Hammer.

B. Provide full size pushbuttons and selector switches.

C. Provide nameplates as specified herein and in accordance with Section 16050, General Electrical Requirements.

2.05 COMBINATION MAGNETIC MOTOR STARTERS

A. Provide motor starters which are a combination motor circuit overload protector and three pole, 60 Hz, rated voltage, magnetically operated, full voltage non-reversing contactor, unless indicated otherwise on the Plans. Provide NEMA sizes as required for horsepower indicated on the Plans, but not smaller than size one. Provide motor circuit protectors rated for supply voltage and phase, with a molded case and adjustable magnetic trip only. Provide motor circuit protectors specifically designed for use with magnetic motor starters.

B. Provide complete starters with an interrupting rating of at least 22,000 amperes at the rated voltage.

C. Provide motor starter(s) that has a 120-volt, 60-Hz operating coil and control power transformer, if necessary. Three phase starters shall have three overload relays. Provide auxiliary contacts as indicated on the Plans or as specified by the Engineer.

D. Provide overload relays that are adjustable, ambient compensated and which may be reset manually.

E. Provide auxiliary contacts (2-NO and 2-NC) for remote alarm indication.

2.06 SWITCHES

A. Provide heavy-duty type, safety switches, with external operating handles, three pole, rated supply voltage class, 60 Hz, with ampere rating as indicated on the Plans.

B. Provide safety switches for rated supply voltage, three phase motors and packaged equipment, as indicated on the Plans. Provide fuses for safety switches as indicated.
2.07 CONTROL PANELS

A. Provide NEMA twelve panels constructed of at least fourteen gauge steel. Provide terminal blocks for connection of external wiring.

B. Provide heavy-duty, oiltight pushbuttons, indicator lights and switches. Provide industrial type relays with 120 volt, 60 Hz operating coils, and contacts rated for intended service. Locate as indicated on the Plans or as specified by the Engineer.

C. Provide nameplates for each panel, and each device on a panel, in accordance with Section 16050, General Electrical Requirements. Provide nameplates of laminated plastic material, at least 3/32 inch thick, with white letters on black background.

2.08 NAMEPLATES

A. Provide nameplates for all equipment of laminated black over white plastic, at least 3/32 inch thick.

B. Provide junction boxes, pull boxes, disconnect switches, control stations and control panels with a nameplate to designate the system wiring contained within.

2.09 MISCELLANEOUS EQUIPMENT MANUFACTURERS


PART 3 - EXECUTION

3.01 GENERAL

A. Make electrical connections required for recording and indicating instruments, and miscellaneous devices. Provide electrical power to metering instrumentation, control, and alarm systems.

B. Connect HAND-OFF-AUTO switches, safety switches, tumbler switches, and other accessory devices for control of motors and other electrical equipment or devices.

C. Install conduit and wiring and make electrical connections between all instrument panels, consoles, cabinets, and external equipment and devices.

D. Install conduit and wiring and make necessary electrical connection between all starters, alarms, and remote indication and control points as indicated on the Plans or as specified by the Engineer.

E. Install conduit and wiring and make necessary electrical connection between control equipment, relays, control wiring, conduit and connections for control of ventilation system. Refer to the Plans for location of ventilators, thermostats and other devices requiring wiring or interconnections with other electrical equipment.

F. Install galvanized steel support channels for interior building mounting of electrical equipment unless otherwise indicated on the Plans.

G. Mount panelboards and enclosures on 7/8 inch galvanized unistrut. All anchoring of conduit or supports to concrete or masonry surfaces shall be accomplished with stainless steel anchors.

H. Install handholes in accordance with manufacturer's printed instructions and as indicated on the Plans.
I. Coordinate handhole locations with other facilities to eliminate any interference with existing or future piping or structures.

J. Do not install handholes in roadways or traffic areas.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes the minimum requirements and specifications for furnishing a solid state Programmable Logic Controller designed to provide high reliability in industrial applications.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 16911 Programming Software for Programmable Logic Controller

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS


B. Underwriter’s Laboratory Listed.

C. CSA certification - Class 1 division 2, Group A, B, C, D.

D. FM Approved - Class 1 division 2, Group A, B, C, D.

1.04 SUBMITTALS

A. The manufacturer shall provide operating instruction manuals with fully detailed procedures pertaining to the following: system specifications, electrical power considerations; step by step assembly and installation procedures; troubleshooting procedures; programming procedures; explanation of internal fault diagnostics; shut down procedures; and recommended spare parts list.

1.05 MANUFACTURERS

A. Programmable Logic Controllers shall be from the Logix family series, manufactured by Allen Bradley, or equal.

1.06 MANUFACTURERS SERVICES

A. The manufacturer shall have a network of field sales and support personnel in San Diego County. They will provide product application assistance by trained and experienced engineers to assist with system development, to include initial system start up, selection of PLC hardware, I/O and communication module choice, development of ladder logic program and de-bugging through telephone consultation and on-site checkout. This support shall be available during normal Water Authority working hours between 6:00 a.m. and 4:30 p.m., Monday through Thursday.

B. The manufacturer shall conduct training programs in San Diego County designed to instruct Water Authority personnel in the programming and application of the programmable controller. The scheduling and start of the training shall be two weeks after the Engineer receives the PLC. The training program shall include training manuals similar to that provided by the manufacturer and the manufacturer shall provide all PLC’s (same model as purchased by the Water Authority) and programming terminals with a ratio of two students per PLC/programming terminal. The training class will be a minimum of four days in length and held during normal Water Authority working hours.

C. The manufacturer shall have a field service department staffed with experienced representatives stationed within San Diego County with the capability of providing on site service. This service will be available...
seven days a week and 24 hours per day with a two-hour minimum call back and be on-site within four hours after the first initial phone call. All hardware components used by the Water Authority will be available seven days a week, 24 hours per day.

1.07 QUALITY ASSURANCE

A. The PLC manufacturer shall have a minimum of ten years of recent and continuous product history in the process control industry manufacturing PLC’s that meet the requirement herein.

PART 2-MATERIALS

2.01 GENERAL

A. The PLC shall be constructed of all new materials. No used or reconditioned equipment is acceptable. The internal wiring of the controller is to be fixed, with logic functions it must perform in a given application to reside in memory. The controller shall be supplied with the CPU, input/output scanner, inputs, outputs, memory, power supply and all power and interface cables necessary to function as a complete and operable programmable controller system.

2.01 CHASSIS/BACKPLANE

A. The chassis/backplane shall be available in at least five different model configurations, including options of four; seven; ten; thirteen and seventeen slot configurations.

B. The chassis/backplane shall not require a specific slot location/assignment for controllers or I/O modules for proper operation.

C. The chassis/backplane shall have full function capabilities to include: message transferring of information, running communication files, sharing of I/O information, and no need for external cabling or power supplies with multiple controllers on same back plane.

D. The chassis/backplane shall allow access to I/O points or any device within any network in the system directly from remote processors with one or more communication links such as Ethernet, ControlNet, DeviceNet, DH+, or Remote I/O.

E. The chassis/back plane shall be the ControlLogix series model 1756, manufactured by Allen Bradley, or equal.

2.02 POWER SUPPLIES

A. The power supply shall be a manufactured and specific part of the modular PLC system so that it plugs into the chassis and is keyed to allow installation in only one direction.

B. The power supply shall automatically shut down the programmable controller system whenever its output power exceeds 125 percent of its rated power.

C. All power supply input power voltage ranges shall be user order selectable. Available voltage input ranges shall be 120VAC, 220VAC, and 24VDC. All power supplies shall provide surge protection, isolation and outage carry-over for 32 milliseconds, two cycles of the AC line.

D. A single main power supply shall have the capability of supplying power to CPU and local I/O and all other modules on the chassis/backplane.

E. The power supply shall include a diagnostic indicator mounted in a position to be easily viewed by the user. This indicator shall provide the status of the DC power supplied. In addition, a means of disabling
power to the chassis mounted modules shall be possible from a power disconnect switch mounted in a position easily accessible by the operator.

F. The power supply shall be a ControlLogix series model 1756, manufactured by Allen Bradley, or equal.

2.03 CONTROLLER HARDWARE

A. Controller will be a manufactured and specific part of the PLC system so that it plugs into the chassis and is keyed to allow installation in only one direction. All system and signal power to the controller and support modules shall be distributed on a single backplane. No interconnecting wiring between these modules via plug-terminated jumpers shall be acceptable.

B. The user program and data shall be contained in non-volatile, battery backed memory. The operating system shall be contained in non-volatile firmware.

C. The memory containing the operating system shall be capable of being updated via a separate update software tool. This update tool will be available by accessing the manufactures electronic internet site or electronic mail or by mail from the manufacturer to allow for easy field updates.

D. The controller shall contain a minimum of 160 Kbytes of base memory. Memory expansion cards shall be available to be added to the controller. These expansion cards shall include at a minimum of: 512Kbytes, 1Mbytes, and 2Mbytes of added memory.

E. The CPU within the system shall perform internal diagnostic checking and give visual indication to the user by illuminating a “green” (OK) indicator when no fault is detected and a “red” indicator when a fault is detected.

F. The front panel on the controller shall include color indicators showing the following status indicators:

1. Program or Run mode of the controller.
2. The fault status of the controller.
3. I/O status.
4. RS-232 activity.
5. Battery status.

G. The front panel of the controller shall include a mounted keyswitch. The key shall select the following Controller modes: RUN - No control logic edits possible, program always executing; PROGRAM - Programming allowed, program execution disabled; and REMOTE - Programming terminal can make edits and change processor mode, including test mode, whereby the logic executes and inputs are monitored, but edits are not permanently active unless assembled.

H. The front panel of the controller shall include a holder and connector for a lithium battery. The battery shall provide power backup for user programs and data when the main power is not available. No memory or program loss shall occur and user shall be allowed to stay in online “Run mode” during the changing of the battery.

I. All modules’ shall have the capability to be removed or inserted into the chassis while power is being supplied to the chassis without faulting the processor or damaging the modules. Upon start up after insertion of the module, while power is applied, dependent on the programmed function of the error subroutine, the processor is capable of starting on line or off line.
J. The controller shall have the capability of addressing at least 128,000 discrete points of Discrete Input and Discrete Output or 4000 analog points. It shall also have the ability to communicate with at least 250 Physical nodes (Control Net) that contain I/O. These calculations are based upon the connection limitation of the controller (i.e. 250 connections * 16 channels per module = 4000 analog inputs).

K. The controller shall provide the capability of addressing remote input and output modules, (250 by 16 points) without distance limitations on Ethernet and Control Net communication modes.

L. The controller shall use multiple independent, asynchronous scans of routines, subroutines, interrupts, messages, and program communications. These continuous scans shall be designated for processing of input and output information, program logic, and background processing of other processor functions. Input and output devices located in the same backplane (local I/O) as the CPU will produce at the rate of configured RPI, and for inputs enabled for Change of States, at the time any point changes state.

M. The controller shall have backward compatibility allowing it to communicate to any module within the Logix family manufactured by Allen Bradley, or equal, or third party devices, (I/O or communication) regardless of firmware version or series.

N. The Controller (CPU Module) shall be a ControlLogix series model 1756, manufactured by Allen Bradley, or equal.

2.04 INPUT/OUTPUT MODULES

A. All I/O modules shall be of the modular type, (can be interchanged at anytime, not a fixed module to the processor or chassis) and plug into the Controllogix chassis. The modules shall be mechanically keyed to allow installation in only one direction. There shall also be electronic keying between each module and processor to guard against the installation of the wrong type or revision of module in a particular slot.

B. All I/O modules shall have removable terminal blocks, screw-clamp or spring-clamp, to provide interconnection of module to wiring terminations. Removable terminal blocks shall be ControlLogix model 1756 series, manufactured by Allen Bradley, or equal.

C. All Digital I/O modules shall support:
   1. Removal and insertion under power from chassis or field terminations.
   2. Module level fault reporting (Individual I/O points, communication to/from processor, on/off time status).
   3. Field side diagnostics (open coil, short circuit).
   4. Time stamping of data.
   5. Choice of direct-connect or rack-optimized communications.

D. All Digital AC input modules shall provide status indicators on the front of the module for input or output and fault status. Status indicators shall indicate at a minimum short circuit, communications with processor, valid inputs.

E. All settings and configuration for modules shall be through software. All settings shall be configured at the time of programming or after download of program. No switch or hardwire jumpers shall be used.

F. Solid - state digital I/O modules shall cover electrical ranges from 10-265V AC and 10-146V DC.
G. Relay contact output modules shall be available for ranges from 10 thru 265V AC or 5 thru 150V DC with a contact rating of one amperes to five amperes.

H. Digital I/O modules shall be ControlLogix series model 1756, manufactured by Allen Bradley, or equal.

I. Analog I/O modules shall have comprehensive self-diagnostic tests to include: open-input/open loop detection; on-board error checking; two alarm levels for the upper range (Hi and Hi-Hi) plus over range and two alarm levels for the lower range (Lo and Lo-Lo) plus underrange.

J. All analog I/O modules shall have software-selectable features to include digital filtering and range selection per I/O channel. Input range capabilities shall be 020maDC, 420maDC and 010VDC, 0-5VDC and plus or minus 10VDC.

K. Analog modules shall have the capabilities to scale analog input signals to engineering units.

L. Analog I/O modules shall perform the required A/D and D/A conversions with 15-bit resolution and one sign bit and 16-bit resolution.

M. Analog Input/Output modules shall be ControlLogix series model 1756, manufactured by Allen Bradley, or equal.

N. Analog I/O modules shall have the capability to be removed or inserted into the chassis while power is being supplied to the chassis without faulting the processor or damaging the module.

2.05 COMMUNICATION INTERFACES

A. All communication between interface modules shall be exchanged across the chassis/backplane without any main processor involvement.

B. The controller shall have communication interface modules for Ethernet, ControlNet, DeviceNet, DH+, and Remote I/O.

C. The Ethernet interface shall support the following:
   1. Standard TCP/IP communications.
   2. Standard Ethernet media (10base2, 10base5, 10baseT, fiber).
   3. CSMA/CD access method.
   4. Subnet masking.
   5. RJ-45 and AUI ports.
   8. Programmable controller messaging to peer controllers and workstations.
   9. RS232 with full RTS/CTS handshaking.

D. The Ethernet interface shall support bridging to ControlNet, DH+, and DeviceNet to allow configuration (program up/download) and data collection.
E. The manufacturer shall offer industry standard five megabit/sec ControlNet producer/consumer communication capabilities embedded in the Controller as defined by the ControlNet International 2.0 Specification.

F. The ControlNet bridge module shall support a minimum of 64 addressable nodes with a repeater, or 48 taps without a repeater.

G. The ControlNet bridge module shall support Linear, Tree, and Star topologies.

H. The ControlNet communication module shall be a ControlLogix 1756 - CNET, manufactured by Allen Bradley, or equal.

I. The controller shall allow the scheduling of message transfers between peers as a function of the network without the need for programming message instructions in ladder logic. This transfer shall occur at user selectable and repeatable rates.

J. The manufacturer shall offer industry standard 125/250/500 Kbaud DeviceNet Producer/Consumer communication capabilities as defined by the Open Device Net Vendor’s Association.

K. The DeviceNet bridge module shall be able to connect to standard DeviceNet cabling and ODVA specified connectors.

L. The DeviceNet bridge module shall support Linear, Tree and Star topologies. Trees and Stars can be a minimum of 20 feet.

M. The DeviceNet bridge module shall support a maximum of 64 addressable Nodes.

N. The DeviceNet bridge module shall allow access to a DeviceNet network from programmable controllers and host computers on ControlNet or Ethernet.

O. The DeviceNet communication module shall be ControlLogix 1756-DNET, manufactured by Allen Bradley, or equal.

P. It shall be possible to communicate with remote I/O racks or other PLC’s via fiber optic (multimode or singlemode) cable by inserting fiber optic converters into the links. The fiber link must support distances between converters of at least 6500 cable feet on “RIO” or 12 KM on ControlNet.

Q. The controller shall have one dedicated serial port which supports RS-232-C signals. It must be usable for programming and data monitoring and communication purposes.

2.05 STATE CONTROL AND DIAGNOSTICS

A. The Human Machine Interface, a electronic graphical interface that will monitor data shall provide:

1. A fault log for all stations on the network.

2. Operator guidance facilities (Directory of help screens).

3. A maintenance diary.


5. System menu.


8. The ability to “zoom” in on a specific station.

B. It shall be possible to network multiple Programmable Controllers each of which shall report diagnostic information to a common terminal. The HMI shall maintain a fault log.

C. The HMI shall provide operator interface graphic screens generated by the standard diagnostic software. The graphic screens shall be easily accessible using user friendly function keys either via keyboard or operator interface terminal.

D. The system shall provide the following types of diagnostic messages:

   1. Status messages.
   2. Error messages.
   3. Time-out messages.
   4. One valid exit message.
   5. Mismatch message (Data mismatching).

2.06 SHIPPING AND HANDLING

A. The equipment shall be delivered to the Engineer, unopened, in the manufacturer’s packaging, free of any shipping damage. The Engineer shall inspect the equipment before unpacking, and will reject any equipment that appears to be damaged during shipping.

2.07 WARRANTY

A. All equipment shall be warranted by the manufacturer to be free from defects in materials, workmanship, and performance, to meet all performance specifications, and to operate without malfunction resulting directly or indirectly from defective material or workmanship for a period of two years from the date of installation.

B. The manufacturer shall offer a maintenance agreement providing the service of repair after the initial two year warranty period has expired on all hardware purchased by the Water Authority. The maintenance agreement shall allow renewal on a yearly basis unless a 30 day notice of cancellation prior to anniversary date is received. The initial contract cost shall be determined on a per-unit cost that will be negotiated by the Engineer and the manufacturer.

C. The manufacturer shall provide a written guaranty to the continuing availability of all hardware, or its equivalent replacement, that was purchased by the Water Authority. This warranty shall extend for a period of five years. This shall include all PLC modules, power supplies controllers and chassis/backplane.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes the minimum requirements and specifications for furnishing the programming software to program the Programable Logic Controller. This shall include the functions to configure input and output, and communication interface modules.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 16910 Programmable Logic Controller

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. IEC 1131-2 and 1131-3 Ladder Logic Compliant.

1.04 SUBMITTALS

A. Manufacturers installation and descriptive step by step instruction manuals and literature for the programming software.

1.05 MANUFACTURERS

A. Programming software shall be RSLogix 5000, by Rockwell Automation, or equal.

1.06 MANUFACTURERS SERVICES

A. The manufacturer shall have a network of field sales and support personnel in San Diego County. They will provide product application assistance by trained and experienced engineers to design, configure, debug and maintain a PLC’s ladder-logic/function block program through telephone consultation and on-site checkout. This support shall be available during normal Water Authority working hours between 6:00 a.m. and 4:30 p.m., Monday through Thursday, with a two hour call back after the first initial phone call and onsite within four hours from first initial phone call if required. This support service shall also be available seven days a week and 24 hours per day in the event of emergency assistance being required.

B. The manufacturer shall provide an information support service web site for product information, software and firmware updates. This web site shall have the capabilities to be personalized to the firmware and hardware products used by the Water Authority. The support service web site will send updates via e-mail messages to Water Authority personnel advising of such updates.

C. The manufacturer shall conduct training programs in San Diego County designed to teach Water Authority personnel in the design, configuration, and maintenance of a ladder logic/function block programming system. The scheduling and start of the training shall be two weeks after the Water Authority receives the programming software. The manufacturers training program shall include furnishing all training manuals and descriptive literature and equipment required. The course content shall include the memory configuration of the processor, including the program configuration and data configuration setup using the programming software. Training shall be provided on all communication protocols, including Ethernet, Controlnet, Devicenet, and DH+ networks. The training class will be at the minimum of four days in length and to be held during normal Water Authority working hours.
1.07 QUALITY ASSURANCE
A. The programming software manufacturer shall have the minimum of ten years of recent and continuous product history in the process control industry developing programming software that meets the requirement herein.

PART 2 – MATERIALS

2.01 GENERAL
A. The programming software shall be a ladder logic and function block instruction platform using the Microsoft Windows 2000 Professional operating system with full help and pull down menus.

2.02 PROGRAMMING SPECIFICATIONS/TECHNIQUES
A. All programming techniques shall adhere to the IEC 1131-3 compliant interface.
B. The programming software shall be common to the following PLC hardware platforms: Controllogix, Flexlogix, Compactlogix and Softlogix, or equal, which shall allow the exchange of application code between different controller programs and allow the reuse of programming from the other hardware platforms.
C. Software shall have all utilities to connect to any of the processes regardless of revisions and firmware allowing the exchange of application code and the ability to reuse programming between different controllers.
D. The programming software operating system requirements shall be Microsoft Windows NT (version 4 or later) with Service Pack 5 or Microsoft Windows 2000 Professional.
E. Programming software shall be able to import and export tags, including data, label, and time stamp from the database directly to a Microsoft Excel and Access databases.
F. One programming package shall be able to program all Logix series PLC’s manufactured by Allen Bradley, or equal.
G. Manipulate data without the need for indirect addressing.
H. Software shall allow the programmer to identify any individual tag using arrays.
I. Software shall allow the calibration of the I/O modules as well as the setup on the communication modules.
J. Function block routines shall coexist seamlessly with ladder routines in a single controller to allow the Water Authority the ability to program in either format.
K. Programming software shall allow the ability to upload both ladder and function block diagram code and tag name definitions from a controller allowing the original source directly from the controller.

2.03 PROGRAMMING DIAGNOSTICS/EDITING
A. Programming software shall allow online run-time edits, including test edit and assembly, allowing the modification of the application program while in the run mode.
B. Software shall have drag and drop editing allowing the ability to move instructions, logic rungs, routines, programs and tasks either within a single project or between two copies of the software allowing the creation of project libraries.

C. Software shall provide an automatic type-ahead function that works with the instruction set and tag database.

D. The software shall allow the ability to trend a minimum of eight separate values and associated labels simultaneously to assist in histograms for diagnostic and monitoring functions.

E. The software shall perform diagnostics in the ladder diagram, tag and data monitor editors which will allow the ability to cross-reference between tags, description text, edits or instructions.

F. Software shall allow the following functions to force Input and Output values:
   1. Set forces on individual bits and entire values.
   2. Monitor forces in the tag monitor for minimized tag, individual bits, or entire value.
   3. Monitor forces in the ladder editor for both bit and block instructions.

G. Software shall allow multiple users to simultaneously monitor and edit the contents of a running controller.

H. Software shall allow the ability to create data tags by the assignment of name and data type and than be loaded with application program into controller memory to allow self-documented logic.

I. Programming software shall have ability to create new data tags while on line and in run mode.

J. Programming software shall have the capabilities to create customized data types by combining multiple data elements into a compound structure, allowing the ability to name each element or field of a structure for its use in the application program.

K. Software shall be able to create arrays of any data type or data structure to store application information, allowing the ability to match memory layout to the application requirements.

2.04 PROGRAMMING ONLINE HELP SYSTEM/TUTORIALS

A. Software shall have the following features in the help system:
   1. Full step by step instructions on all programming functions.
   2. Comprehensive information on all processor or I/O module.
   3. Instruction reference.
   4. Pull down windows with point and click functions.

B. Software program shall have an integrated online tutorial with comprehensive instructions on the Allen Bradley Logix series hardware, or equal.

C. The programming software tutorial shall include the step by step instructions of using RSLogix to configure communications to the processor.
D. The software tutorial shall have three exercises to illustrate the sequence of steps to follow in configuring the Allen Bradley series ControlLogix system, or equal.

E. Software shall be available in the English language to include; all online help, hardware manuals in PDF format, all software menus, and dialog boxes.

2.05 SHIPPING AND HANDLING

A. The programming software shall be delivered to the Water Authority, unopened, in the manufacturer’s packaging, free of any shipping damage. The Water Authority shall inspect the software before unpacking, and will reject any items that appear to be damaged during shipping.

2.06 WARRANTY

A. All software shall be warranted by the manufacturer to be free from defects in materials, workmanship, and performance, to meet all performance specifications, and to operate without malfunction resulting directly or indirectly from defective material or workmanship for a period of two years from the date of installation.

B. The manufacturer shall offer an agreement providing the service of software support after the initial two year warranty period has expired on all software purchased by the Water Authority. The software support agreement shall allow renewal on a yearly basis unless a 30 day notice of cancellation prior to anniversary date is received. The initial contract cost shall be determined on a per unit cost that will be negotiated by the Water Authority and the manufacturer.

C. The manufacturer shall provide a written guaranty to the continuing availability of all programming software, or its equivalent replacement, that was purchased by the Water Authority. This warranty shall extend for a period of five years. This shall include all programming software for the PLC series hardware purchased by the Water Authority to include, configuration of I/O, communication links and drivers, memory management, HMI.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes general requirements for the project instrumentation system, including providing, installing, and testing as required the following:

1. Remote terminal unit cabinet.
2. Communications cabinet.
3. Interface cabinet.
4. Field-mounted instruments.

B. The Contractor shall calibrate the instrument systems after installation in conformance with component manufacturer's instructions.

C. The Contractor shall exercise the instrument systems through operational tests to demonstrate achievement of the specified performance.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 16160 Cabinets and Consoles

B. Section 16941 Flow Mounted Instruments

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Instrument Society of America.

B. National Electrical Code, ISA S5.3 and S5.4, 1999.

C. National Electrical Manufacturer’s Association.

D. Underwriter’s Laboratory.

E. American National Standards Institute

F. Joint Industrial Council


1.03 SUBMITTALS

A. Detailed systems drawings and data prepared and organized as a complete package in three-ring hardcover binders and arranged for convenient use including tab sheets, all indexed, and cross referenced. Submit data sheets for each component, together with a technical product brochure or bulletin. The data sheets shall show:
1. Component name.

2. Manufacturer's model number.

3. Project tag number.

4. Project location.

5. Input and output characteristics.

6. Scale range and units (if any) and multiplier (if any).

7. Requirements for electric supply.

B. Group the data sheets together in the submittal by systems or loops as a separate group for each system or loop. If within a single system or loop a single component is employed more than once, one data sheet with one brochure or bulletin may cover all identical uses of that component in that system.

C. Component interconnect drawings showing the interconnecting wiring between each component including equipment supplied under other sections, furnished by the Engineer, or supplied under separate contract.

D. Arrangement and construction drawings for consoles, control panels, and for other special enclosed assemblies for field installation. These drawings shall include dimensions, identification of all components, preparation and finish data, nameplates, and the like. These drawings also shall include enough other details to define the style and overall appearance of the assembly; include a finish treatment sample.

E. Installation, mounting, and anchoring details for all components or entry details.

F. Detailed bills of material.

G. Operation, Maintenance, and Repair Manuals:

   1. The organization of the initial submittal required above shall be compatible to eventual inclusion as one volume of the operation, maintenance, and repair manuals.

   2. Prepare and submit six copies of the operation manuals for preliminary review by the Engineer. When the Engineer is satisfied that the preliminary sets are complete and properly prepared, six final sets shall be delivered to the Engineer.

   3. The complete operation manual shall contain all the information included in the preliminary equipment submittal, programming instructions, and the additional information required herein, all bound in hardcover binders and arranged for convenient use including tab sheets, all indexed and cross referenced, and all final as-built drawings.

   4. The operation manuals shall contain: (1) calibration and maintenance instructions, (2) troubleshooting instructions, and (3) instructions for ordering replacement parts.

1.04 QUALIFICATIONS AND RESPONSIBILITY OF CONTRACTOR

A. Furnish and install all proposed hardware as indicated on the Plans and as specified herein, including wiring and connections to peripheral equipment and instruments to provide a complete and functional instrumentation system. Use qualified personnel that are experienced in the work to which they are assigned, and supply the workers with the proper tools to insure safe and reliable completion of their tasks.
The Contractor shall have a minimum of five years' experience with the installation of systems similar to those to be installed in this project. Furnish evidence meeting the experience requirements prior to commencement of any work. Qualifying evidence shall include the following:

1. A list of completed similar installations with name and address of owner, owner contact information, name of project, and date of completion.

2. The name and qualifications of supervisory personnel directly responsible for the installation of the control system.

B. The Contractor shall be responsible for coordinating and interfacing with instrumentation system equipment supplied and/or installed by others. This interfacing shall be detailed in the systems drawings, or other contract sections.

C. All field instruments shall be new. No used parts shall be installed. Manufacturers and model or type numbers are provided as part of the instrument narrative descriptions. The proposed manufacturers are those on which the instrument system design has been based.

D. The Engineer will witness calibration and final checkout of the instrumentation system to determine if the system complies with the contract documents.

1.05 GUARANTEE

A. During the warranty period, repair or replace defective components, rectify malfunctions, and correct faulty workmanship, all at no additional cost to the Water Authority. To fulfill this obligation, the Contractor shall only use workers that are trained and experienced with the specific equipment being repaired. The Contractor shall, upon request, provide the Engineer documentation of the training and experience of all workers assigned to warranty repair work. Warranty repair services shall be performed by the Contractor within five calendar days after notification by the Engineer.

PART 2 - MATERIALS

2.01 DESIGNATIONS OF COMPONENTS

A. In these specifications and on the drawings, all systems and other elements are represented schematically and are designated by numbers, as derived from criteria in ISA Standards. The nomenclature and numbers designed herein and on the plans shall be employed exclusively throughout shop drawings, data sheets, and the like. Any other symbols, designations, and nomenclature unique to a manufacturer's standard methods shall not replace those prescribed above, as used herein, and on the Plans.

2.02 INSTRUMENT TAGGING

A. Attach a stainless steel tag to each instrument. Permanently mark the stainless steel tag with the instrument tag number. The manufacturer's standard metal nameplate as a minimum shall denote model number, serial number, operating electrical voltage and amperage (when applicable), and date of manufacture.

2.03 INSTRUMENT SYSTEM POWER

A. Power provided for the instrument system at the facility shall be 120 volt ac, single phase, 60 Hz.

B. Provide separate solid-state power supplies where dc power supplies are not furnished as an integral part of any instrument system loop.
2.04 MATCHING STYLE, APPEARANCE, AND TYPE

A. All display instruments of each type shall represent the same outward appearance, having the same physical size and shape and the same size and style of numbers and pointers.

PART 3 - EXECUTION

3.01 UNIFORMITY OF COMPONENTS

A. Components that perform the same or similar functions shall, to the greatest degree possible, be the same or similar type, the same manufacturer, the same grade of construction, the same size, and the same appearance.

3.02 MOUNTING OF EQUIPMENT AND ACCESSORIES

A. The Plans may diagrammatically indicate the desired location and arrangement of equipment. Field verify exact location based on physical size and arrangement of equipment, finished elevations, and obstructions, and submit such location for approval by the Engineer prior to installation.

B. Mount equipment in accordance with the installation detail drawings as prepared by the Contractor and reviewed by the Engineer. Mount equipment so that it is rigidly supported, level and plumb, and in such a manner as to provide accessibility; protection from damage; isolation from heat, shock, and vibration; and freedom from interference with other equipment, piping, and electrical work. Do not install consoles, cabinets, and panels until heavy construction work adjacent to these enclosures has been completed to the extent that there shall be no damage to the enclosures or their contents.

C. Locate devices, including accessories, where they shall be accessible from grade, except as indicated otherwise.

D. Mount local equipment in cabinets or existing panels as specified. Mount associated I/O terminals on a common panel or rack. Mounting panels and racks shall be coated with baked enamel or epoxy finishes.

E. Install electrical power services to all components of the instrumentation system in a manner that assures a compatible and functionally correct system.

F. Coordinate and supervise the installation of all accessories to the instrumentation system.

G. Test the completed system after installation to insure that all components are operating within the specified range, and that all interlocks are functioning properly.

3.03 CALIBRATION

A. Each instrument requiring factory calibration shall be furnished with calibration data. The calibration data shall be factory certified.

B. Calibrate instrumentation systems, after installation, in conformance with the component manufacturer’s instructions. The Contractor is responsible for setting all adjustable or programmable features of all instrumentation system components for the specific conditions and applications of each installation. The instrumentation system components and/or subsystems shall perform within the limits of accuracy specified by the instrumentation system designer.

C. The Contractor is responsible for calibrating all components or subsystems of the instrumentation system, before placing the system in operation. Employ a technical field representative, certified by the manufacturer of each instrument, to accomplish this calibration work. Prior to operation of the
instrumentation system, certify that all calibrations have been made and that all systems are ready to operate. This certification shall include a field calibration sheet stating the parameters and assumptions making up the calibration. This sheet shall be immediately forwarded to the Engineer for review and formal acceptance once the calibration has been performed. Defective elements of the instrumentation system, that cannot achieve proper calibration or accuracy, either individually or within a system, shall be replaced by the Contractor at his expense.

3.04 FIELD TESTING

A. Exercise systems through operational tests in the presence of the Engineer to demonstrate achievement of the specified performance. Coordinate operational tests dependent upon completion of work specified elsewhere, and schedule tests among all parties involved so that the tests may proceed without delays or disruption by uncompleted work.

3.05 STARTUP

A. Upon concurrence of the Engineer that the instrumentation system has successfully functioned through a complete operational test, a date for system startup involving the Water Authority's operating personnel will be determined.

B. Recheck the instrumentation system before the startup to verify proper operation. The system shall be operationally tested for a period of 14 consecutive days. The operational tests must have a success factor of 95 percent system uptime to be considered successful. If the system should fall below the 95 percent system uptime factor, the Contractor shall correct the system problems, and system operational testing shall be restarted for another 14 day period. This will continue until the system functions for 14 consecutive days with a 95 percent uptime success factor.

3.06 OPERATOR TRAINING

A. Provide the Water Authority's operating personnel with one day of formal instruction in the functions and operations of each system provided under this contract. Emphasis shall be placed on safety features and features which may require periodic maintenance, readjustment, resetting, checking, or recalibration.

B. Provide the training sessions at the Water Authority's facilities and on the equipment furnished under this contract. Provide education and instruction of operating personnel shall be by a qualified instructor familiar with the equipment and operational requirements of this project. Each training session shall be eight hours of formal instruction. The training schedule shall be determined by the Engineer.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This section describes furnishing, installing, calibrating, and testing of differential-pressure transducers for measuring water flow, pressure transducers for measuring water pressure, and three-valve instrumentation manifolds for differential pressure transducers. Perform work as specified to provide complete, operational, and functional pressure measurement systems.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 15155 Venturi Meter
B. Section 16050 General Electrical Requirements
C. Section 16110 Raceways and Fittings
D. Section 16450 Grounding
E. Section 16940 General Instrumentation System Requirements

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Occupational Safety and Health Administration
   OSHA Part 1910; Subpart S, 1910.308.
   OSHA Part 1926; Subpart V, 1926.950 through 1926.960.
B. National Fire Protection Association
   70 National Electrical Code.
   70B Electrical Equipment Maintenance.
   70E Electrical Safety Requirements for Employer Workplaces.
   78 Lightning Protection Code.
C. American National Standards Institute
   Z244-1 Personnel Protection.

1.04 SUBMITTALS

A. Shop drawings, product data, and descriptive literature for all materials, coatings, equipment, apparatus, and other items as specified. Include the manufacturer's name, product designation, catalog numbers, dimensions, materials of construction, and a certification statement that all connections are compatible. Mark
all shop drawings and data submitted so that drawings and manuals clearly indicate the items applicable to the work to be performed.

B. Complete operations and maintenance manuals for all equipment furnished under this section. Include all required cuts, drawings, equipment lists, descriptions, troubleshooting lists, complete spare parts lists, and complete schematic drawings.

C. A list of all nameplates and identification tags to be installed on all devices. Data for the identification tags shall include serial number (if any), and pressure class.

D. Samples of materials or manufacturer's specifications, if requested by the Engineer.

E. Qualifications of all field technicians that will be used to install, calibrate or test field mounted instruments.

1.05 MANUFACTURERS

A. The differential pressure flow transmitter shall be manufactured by SMAR International Corp., model LD301-D31I-BU11-012/I1/A1, or Endress-Hauser model PMD230-SU3H4EH1D, or equal. All transmitters shall be equipped with the latest version firmware.

B. The pressure transmitter shall be Smar International Corp., Series LD301M41I-BU11-012/I1/A1, or Endress-Hauser model PMC731-R51S6M21N1, or equal. All transmitters shall be equipped with the latest version firmware.

C. The 3-Valve manifolds for differential pressure transducers shall be manufactured by Century Valve Company, model CM3-1-F29-CD-T, or manufactured by PFS Inc., model 3MV-SDCWA, or equal.

1.06 QUALIFICATIONS

A. Manufacturers shall have a minimum of ten years of continuous product history manufacturing transducers and manifolds specified herein.

B. Testing and calibration is to be performed by qualified personnel skilled in the particular tests being conducted. Personnel shall have at least five years of experience calibrating and testing instruments of the same type and size as specified.

1.07 WARRANTY

A. The manifold and valves shall be warranted by the manufacturer to be free from defects in materials, workmanship, and performance, to meet all performance specifications, and to operate without malfunction resulting directly or indirectly from defective material or workmanship for a period of two years from delivery date.

PART 2 – MATERIALS

2.01 GENERAL

A. The furnished pressure measuring system shall be complete and functional. Furnish all material that is incidental to the work of this section.

B. Furnish Underwriter's Laboratories listed and labeled devices and materials. Where UL listing is not available for equipment, submit test reports of an independent testing laboratory, approved by the Engineer, indicating that the equipment is in conformance with NEC, state, and local code requirements.
C. Furnish equipment, devices, and material marked with name or trademark of the manufacturer and other pertinent information on a nameplate.

D. Furnish only products which are new, undamaged, and in the original cartons or containers.

E. Protect pressure-measuring equipment at all times against mechanical and moisture damage. Transducers shall be stored indoors. Store transducers in dry areas. Replace any apparatus that has been moisture damaged.

F. Three-valve manifold body shall be manufactured from ASTM 316L or 304L stainless steel, no exceptions.

G. All valves installed in the manifold body shall conform to ASTM and AWWA specifications for the intended service.

H. Manufacturer shall supply transducers and manifolds that are constructed of new materials.

2.02 DIFFERENTIAL PRESSURE TRANSMITTER

A. The differential-pressure transmitter shall be capable of operation from 17 - 42 VDC, supplied from a two-wire control loop. The transmitter shall be scalable between 0 - 33 inches of water column and 0 - 330 IWC. The transmitter shall provide a 4-20 mA signal to the control loop, with optional Foundation fieldbus output. Provide a differential-pressure transmitter with the following features and accessories:

1. Transmitter shall not weigh more than 10 pounds.

2. Transmitter shall occupy less than 0.5 cubic feet of space.

3. Transmitter shall provide traditional 2.125 inch flange mounting for process inputs, no exceptions. Transmitter flange mount shall be suitable for use with a model CM3-1-F29-CD-T manifold, manufactured by Century Valve Company, or a model 3MV-SDCWA manifold manufactured by PFS Inc., or equal manifold. Deliver each transmitter with this manifold mounted to the transmitter. Mount the transmitter to the manifold so that the high-pressure side of the transmitter is on the left side of the manifold, as viewed from the front of the manifold.

4. Transmitter shall provide a sealed NEMA-4 enclosure with field termination section fully isolated from electronics section of transmitter housing.

5. Transmitter shall be corrosion-resistant construction with stainless steel measurement cell. All exterior hardware shall be stainless steel of the same type as the measurement cell.

6. Transmitter shall provide a 1/2 inch - 14 NPT conduit entry into the electronic termination section of enclosure.

7. Transmitter shall provide integral vent/drain valves for the measurement cell.

8. Transmitter shall include an integral display with characters at least 1/2 inch in height. Displayed information shall be user selectable via programming interface.

9. Integral display shall swivel over 270 degrees in the horizontal plane to allow various mounting positions for transmitter.

10. Transmitter shall withstand common mode over-pressurizations of the measurement cell to 2000 PSI without sustaining internal damage, degrading measurement accuracy, or causing a zero-point shift of greater than 0.2 IWC. Transmitter shall withstand over-pressurizations of a single side of
the measurement cell to 300 PSI without sustaining internal damage, degrading measurement accuracy, or causing a zero-point shift of greater than 0.2 IWC.

11. Transmitter shall operate over a temperature range of minus 40 degrees F to plus 200 degrees F.

12. Transmitter shall store all programmable information in nonvolatile EEPROM memory, and maintain sensor characterization data as an integral part of the sensor.

13. Transmitter shall continuously perform self-diagnostics and respond to internal malfunctions via a user programmable failsafe mode, allowing user selection of upscale, downscale, and hold last output failsafe modes.

14. Transmitter shall be fully programmable, communicating via hand-held terminal or Palm terminal, allowing programmer access to the following features:
   a. User selectable input scaling in units of PSI, inches of water, feet of water.
   b. User selectable display of measurement units and accessory data via integral display.
   c. User selectable damping over the range of 0 - 30 seconds.
   d. User selectable upscale/downscale/hold last output failsafe modes.
   e. User selectable password security for access to all programmable functions.
   f. User selectable zero-cutoff mode; functional between zero, and 20 percent of linear output.
   g. Programmable data fields to identify the unit, owner, and installation date.
   h. Programmable zero trim for pressure input and current output.
   i. Programmable span trim for pressure input and current output.
   j. Independent adjustment of zero and span

15. Transmitter shall have turndown capability to allow calibrated span of 0 - 33 IWC with a minimum accuracy of plus or minus 0.2 percent of reading, and a calibrated span of 0 - 330 IWC with a minimum accuracy of plus or minus 0.075 percent of reading.

16. Output signal shall drift less than plus or minus 0.2 IWC over a twelve-month period.

17. Transmitter shall allow replacement of electronics or sensor assembly in the field, without loss of accuracy or need for bench calibration.

18. Transmitter shall allow access to all programmable features via a HART 275 12MB Handheld (Model Number 275R1E10D0000). Furnish all necessary software, user licenses, and interface cabling for programming of the transmitter.

19. Manufacturer shall equip the transmitter with the latest software and firmware available as of the delivery date of the transmitter to the Water Authority.

20. Manufacturer shall provide a Windows (98/2000) based software interface that allows access to all programmable features of the transmitter from a PC type laptop computer. Provide all hardware necessary to connect the PC to the transmitter.
21. Transmitter shall offer HART communication mode as a standard feature.

22. Transmitter shall offer, as an option, Foundation fieldbus, and the transmitter shall accept this option as a field-modification.

2.03 PRESSURE TRANSMITTERS

A. The pressure transmitter shall be capable of operation from 17 - 42 VDC, supplied from a two-wire control loop. The transmitter shall be scalable between 0 - 30 PSIG and 0 - 600 PSIG, with an accuracy of at least plus or minus 0.1 percent of calibrated span. The transmitter shall provide a 4-20 mA signal to the control loop, with optional Foundation fieldbus output. Provide the pressure transmitter with the following features and accessories:

1. Transmitter shall not weigh more than 10 pounds.

2. Transmitter shall occupy less than 0.5 cubic feet of space.

3. If the transmitter utilizes a traditional flange mounting for process inputs, deliver each transmitter with an Oliver Valves model Y24S manifold, or functional equivalent. If the transmitter uses a 1/2-inch NPT process connection, deliver each transmitter with a block and bleed manifold that is functionally equivalent to the Oliver model Y24S, including mounting capability. Water Authority standard drawings are based on the Oliver manifold, and any additional costs incurred through use of a substitute manifold are the sole responsibility of the Contractor. Deliver each transmitter with the manifold mounted to the transmitter.

4. Transmitter shall provide a sealed NEMA-4 enclosure with field termination section fully isolated from electronics section of transmitter housing.

5. Transmitter shall be corrosion-resistant construction with stainless steel measurement cell. All exterior hardware shall be stainless steel of the same type as the measurement cell.

6. Transmitter shall provide a 1/2 inch - 14 NPT conduit entry into the electronic termination section of enclosure.

7. Transmitter shall provide integral vent/drain valves for the measurement cell.

8. Transmitter shall include an integral display with characters at least 1/2 inches in height. Displayed information shall be user selectable via programming interface.

9. Integral display shall swivel over 270 degrees in the horizontal plane to allow various mounting positions for transmitter.

10. Transmitter shall withstand over-pressurizations of the measurement cell to 2000 PSI without sustaining internal damage, degrading measurement accuracy, or causing a zero-point shift of greater than 0.2 PSI.

11. Transmitter shall operate over a temperature range of minus 40 degrees F to plus 200 degrees F.

12. Transmitter shall store all programmable information in nonvolatile EEPROM memory, and maintain sensor characterization data as an integral part of the sensor.

13. Transmitter shall continuously perform self-diagnostics and respond to internal malfunctions via the user programmable failsafe mode, allowing user selection of upscale, downscale, and hold last output failsafe modes.
14. Transmitter shall be fully programmable, communicating via a HART 275 12MB Handheld (Model Number 275R1E10D0000) allowing programmer access to the following features:

   a. User selectable input scaling in units of PSI, inches of water, feet of water.
   b. User selectable display of measurement units and accessory data via integral display.
   c. User selectable damping over the range of 0 - 30 seconds.
   d. User selectable upscale/downscale/hold last output failsafe modes.
   e. User selectable password security for access to all programmable functions.
   f. Programmable data fields to identify the unit, owner, installation date.
   g. Programmable data fields to identify the unit, owner, and installation date.
   h. Programmable span trim for pressure input and current output.
   i. Independent adjustment of zero and span.

15. Transmitter shall have turndown capability to allow calibrated span of 0 - 100 PSI with a minimum accuracy of plus or minus 0.1 percent of reading, and a calibrated span of 0 - 30 PSI with a minimum accuracy of plus or minus 0.2 percent of reading.

16. Output signal shall drift less than plus or minus 0.5 PSI over a 12-month period.

17. Transmitter shall allow replacement of electronics or sensor assembly in the field, without loss of accuracy or need for bench calibration.

18. Transmitter shall allow access to all programmable features via a HART 275 12MB Handheld (Model Number 275R1E10D0000). Furnish all necessary software, user licenses, and interface cabling for programming of the transmitter.

19. Manufacturer shall equip the transmitter with the latest software and firmware available as of the delivery date of the transmitter to the Water Authority.

20. Manufacturer shall provide a Windows (98/2000) based software interface that allows access to all programmable features of the transmitter from a PC type laptop computer. Provide all hardware necessary to connect the PC to the transmitter.

21. Transmitter shall offer HART communication mode as a standard feature.

22. Transmitter shall offer, as an option, Foundation fieldbus, and the transmitter shall accept this option as a field-modification.

2.04 3-VALVE MANIFOLD

A. The manifold shall be suitable for use with any differential pressure transducer that has standard 2.125-inch sensor spacing, and shall conform exactly to all aspects of the Water Authority's standard design.

B. The manifold shall be suitable for service in all Water Authority flow control facilities. These facilities are subject to temperatures between zero and 120 degrees F, and moisture conditions including total submersion in water.
C. The manifold shall consist of a single block of stainless steel, machined to accept the valves, provide process connections, provide a transducer mounting location, provide test ports for calibration of the transducer, and provide a mounting location for the two-inch pipe stand.

D. The manifold shall be physically arranged to place the process inlet connections on the bottom of the manifold, the process isolation valves on the sides of the manifold, and the crossover valve, test ports, and all mounting bolts on the front of the manifold. The differential pressure transducer and pipe stand shall be mounted to the back of the manifold. All positional references are made with respect to the position the manifold will occupy when mounted in the field.

E. The manifold and all valves shall be designed for service at pressures of at least 300 PSIG.

F. The manifold body shall have 1/4 -inch 18 NPT female connections for each of the process inputs.

G. The manifold body shall have a mounting flange for the differential pressure transducer that is compatible with a standard differential pressure transducer, having standard 2.125 inch sensor spacing.

H. The manifold body shall have two 1/4-inch 18 NPT female connections for the test ports. The test ports shall be located on the front of the manifold, and positioned to allow all water to gravity drain out of the transducer and manifold when the test ports are opened and the process isolation valves are closed.

I. The manifold body shall have an integral mount that is suitable for mounting the manifold onto a vertical section of two-inch galvanized schedule 40-pipe. All mounting hardware necessary for mounting the manifold to the two-inch pipe stand shall be of the same variety of stainless steel used for the manifold body, and shall be supplied with the manifold at no additional cost.

J. The manifold shall be supplied with Stainless steel bolts for mounting the differential-pressure transmitter to the manifold. These bolts shall be of a sufficient length to insure engagement of at least ten threads of the mounting flange of the transmitter. Provide bolts of the same type stainless steel as the manifold body.

K. Provide two sets of manifold to transmitter gaskets for each manifold supplied. Construct all gaskets to be suitable for the intended service conditions.

L. The manifold shall not be painted or coated.

M. Provide a laboratory certification that each manifold supplied has been tested for leaks at a pressure not less than 300 PSIG.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The Plans indicate connections for typical equipment only. If the equipment furnished is different from what is shown, provide the modifications necessary for a safe and properly operating installation in accordance with the National Electric Code requirements, AWWA and ASME recommended practices, and the equipment manufacturer's recommendations.

B. The Plans diagrammatically indicate the desired location and arrangement of transducers, and other items. Field verify exact location based on physical size and arrangement of equipment, finished elevations, and obstructions, and submit such location for approval by the Engineer prior to installation.

C. Accomplish all work and furnish and install all equipment not indicated or specified which is necessary for the intended complete operation of the pressure sensing system.
3.02 SUPERVISION AND COORDINATION

A. Provide supervision on the site at all times to layout, check, coordinate, and supervise the installation of all transducers. Plan the installation of all transducers, giving consideration to the work of other trades to prevent interference.

3.03 INTERPRETATION OF DRAWINGS

A. Determine transducer locations that conform to the installation requirements set forth herein.

B. Install transducers as shown on the Plans.

C. Verify with the Engineer the exact locations and mounting heights of transducers prior to installation.

D. Support surface mounted equipment with galvanized or Stainless Steel unistrut to provide a 7/8-inch clearance between walls and equipment. Securely mount unistrut with stainless steel anchors.

E. Make connections to equipment as required and in accordance with approved shop drawings.

3.04 SHIPPING AND ASSEMBLY

A. All equipment shall be shipped and handled, and assembled, if necessary, at the job site in accordance with the manufacturer's requirements to maintain functional integrity.

3.05 COMPONENT INTERCONNECTIONS

A. Analyze all system components, identify terminals, and prepare drawings or wiring tables necessary for component interconnection.

B. Furnish and install all component interconnections.

3.07 FINAL RECORD DRAWINGS

A. Provide an accurate record of the installation as work is carried out, including connections to equipment. Provide accurate records of the internal connections and functions of the equipment installed. Record drawings shall include, but not be limited to, the following:

1. All amendments and additions to the location of equipment.

2. New drawings of any modified detail from the Plans.

3.08 TESTING

A. Provide supervision, labor, materials, tools, test instruments, and all other equipment or services required to test, adjust, set, calibrate, and operationally check all components of the pressure measurement systems and circuitry.

B. Tests are to provide initial equipment/system acceptance, provide recorded data for future maintenance and trouble shooting, and provide assurance that each system component is installed satisfactorily and can be expected to perform, and continue to perform, its function with reasonable reliability.

C. Pay for all tests specified including expenses incident to retesting occasioned by defects and failures of equipment to meet specification.
D. Prior to testing and start-up, permanently identify all equipment with nameplates. Check and tighten terminals and connection points, remove shipping blocks, thoroughly clean equipment, repair damaged or scratched finishes, inspect for broken and missing parts, and review and collect manufacturer's drawings and instructions for delivery to the Engineer. Make routine checks and tests as the job progresses to ensure that wiring and equipment is properly installed.

E. Do not void equipment warranties or guarantees by testing. Checks and tests shall be supplemental to and compatible with the manufacturer's installation instruction. Where deviations are warranted, obtain the manufacturers written approval prior to testing. Where any repairs, modifications, adjustments, or tests are to be made, the Contractor shall notify the Engineer and make such repairs, modifications, adjustments and tests in accordance with the manufacturer's recommendations.

F. Report to the Engineer any pressure measuring equipment or system determined to be damaged, or faulty. Obtain approval from the Engineer for any corrective action and retesting. Replace defective equipment.

3.09 TEST EQUIPMENT

A. Perform calibration and setting checks with calibrated test instruments of at least twice the accuracy of the equipment under test. Dated calibration labels shall be visible on test equipment. Calibrations over six months old are not acceptable on field test instruments. Inspect test instruments for proper operation prior to testing. Record the serial and model numbers of the instruments used on the test forms.

3.10 TEST PROCEDURES

A. Schedule tests and inspections as the job progresses.

B. Conduct tests in presence of the Engineer. Notify the Engineer seven days in advance of any test scheduled to be performed.

C. After each pressure measurement system installation is complete, perform the tests to determine that the entire system is in proper working order and in accordance with applicable codes, manufacturer's instructions, drawings, and specifications.

END OF SECTION