

## SECTION 01100

### GENERAL REQUIREMENTS

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. General Requirements govern the execution of the work of all sections of the Specifications.

##### 1.02 ABBREVIATIONS & DEFINITIONS

- A. AASHTO: American Association of State Highway and Transportation Officials, current designation.
- B. ASTM : American Society for Testing Materials, current designation.
- C. AWWA: American Water Works Association, current designation.
- D. Board: The elected Board of Directors of Solano Irrigation District.
- E. Construction Observer/Inspector: All persons employed and/or authorized by the District responsible for the observation and verification of Work, actions and materials accomplished or utilized by the Contractor on District facilities. The purpose of the Observer/Inspector is to assure that the constructed Work complies with all requirements of the design and Contract Documents including referenced standards and all applicable regulations. The Observer/Inspector is not responsible for the acceptance of Work or materials
- F. Contractor: Any person, firm, partnership, subdivider, company or corporation supply the materials or doing the work of installing District facilities.
- G. District: Solano Irrigation District.
- H. Engineer: The District Engineer of Solano Irrigation District or his designated representative.
- I. MUTCD: Manual on Uniform Traffic Control Devices, latest revision.
- J. USA: Underground Service Alert.

##### 1.03 REFERENCE STANDARDS

- A. All construction of District water systems shall conform to the AWWA Standards unless otherwise noted in this Section.

- B. The California Waterworks Specifications, being the California Code of Regulations, Title 22, Division 4, Chapter 16.

#### 1.04 SCHEDULING AND COORDINATION

- A. The existing irrigation canals and pipelines will remain in service during the irrigation season, typically March 1<sup>st</sup> to October 15<sup>th</sup>, or as required to meet the irrigation demands. This may include beginning or ending the irrigation season outside of the typical irrigation season, at the District's discretion. The canals or pipelines will not be dewatered during irrigation season. If any canal or pipeline needs to remain in service, the District will cooperate with the Contractor so that certain connections and crossings can be made, provided sufficient notice is given to the District that such interruption of service is necessary. The existing drainage ditches will remain in service for the area. The Contractor shall provide approved means to cross the drainage ditches as required.
- B. If the Developer or Contractor wishes to perform construction activities that may affect, in the District's opinion, the irrigation delivery facilities, written approval must be granted prior to beginning construction.
  - 1. The Developer or Contractor must submit a detailed construction schedule which must include a contingency plan. The plan must also contain a "Construction not to be begun after" date.
  - 2. The Contractor may be required to obtain the proper City or County permit(s) authorizing the Contractor to work nights, weekends and/or holidays.
  - 3. Approval for such work shall include written authorization from the Engineer, Water & Power Operations Manager, General Manager and the Board of Directors.
  - 4. The Developer's or Contractor's proposal must be given to the District the first week of the month in order to be placed on the Board meeting agenda.
  - 5. The proposal must be prepared and submitted to the Board of Directors for approval at the regular Board Meeting before the proposed construction commencement date. The Board of Directors regularly meets on the 3<sup>rd</sup> Tuesday of each month.
  - 6. **All parts, materials and equipment must be on-site before the proposal is presented to the Board for approval.** Parts, materials or equipment that is on-order or in-route is not on-site. If the above condition is not met, the proposal shall be removed from the Board meeting agenda, no exceptions shall be made.
  - 7. The Developer or Contractor may be required to furnish a surety bond for

the construction and enter into a construction contract/agreement with the District.

- C. The Contractor shall submit, at such times as may be requested by the Engineer, schedules which shall show the order in which the Contractor proposes to carry on the work with dates at which the Contractor will start the several parts of the work and estimated date of completion of the several parts.

#### 1.05 GROUNDWATER AND DEWATERING

- A. GENERAL. The Contractor shall provide all groundwater control and dewatering necessary to keep the construction and work areas in manner in which the permanent work be accomplished on a dry and stable subgrade.
  - 1. The District will complete the initial removal of the irrigation water from the canal, ditch and pipeline. This means the District will open the spill gates/controls and the canal, ditch or pipeline will dewater naturally by gravity. This will not completely remove all of the water.
    - a. The initial removal of the irrigation water **may not** provide the Contractor with a construction site suitable for immediate workability.
    - b. Additional dewatering due to canal, pipeline, groundwater seepage, runoff or rainfall shall be at the responsibility of the Contractor.
  - 2. The Contractor shall design, install, operate, and maintain an adequate system.
  - 3. The system shall be of sufficient size and capacity to maintain a dry condition without delays to construction operations.
  - 4. Perimeter and diversion ditches and dikes may be required and must be maintained as necessary to prevent surface water from entering any excavation.
  - 5. Seepage of any water from excavated slopes shall be controlled to prevent sloughing, and ponding of water in the excavation shall be prevented during construction operations.
  - 6. If the flow of water into an excavation becomes excessive and cannot be controlled by the dewatering system that the Contractor has installed, excavation shall cease until satisfactory remedial measures have been taken.
  - 7. Construction typically takes place in the early fall/winter and may extend into the rainy season. Forecasted rainfalls which may be considered minor may include periods of intense isolated rain cells and should be considered.

8. The Contractor is not relieved of responsibility of controlling and disposing of all water, even though the discharge of the dewatering system required to maintain satisfactory conditions in the excavation may be in excess of the anticipated and/or planned quantities.
- B. SUBMITTALS. The Contractor may be required to submit a *Proposed Dewatering Plan* for approval by the Engineer prior to initiation of any construction or excavation operations.
1. The plan shall show all facilities proposed for complying with this section, including the method for dewatering the excavation, controlling surface runoff, disposing of the water, and removing the system, as well as a list of the equipment to be used.
  2. The plan should be detailed and adaptable to the site conditions and should provide a contingency plan for around-the-clock dewatering operation, as required.
- C. PAYMENTS. Payment for all work covered in this section will be made by one of two methods, contract lump sum or inclusive within the project, as established by the Bid Schedule.
1. Lump sum: a separate line item in the Bid Schedule for “Dewatering,” which price will constitute full compensation for furnishing all equipment, labor, and materials to install, operate, maintain, and remove the dewatering system.
  2. Project inclusive: full compensation for furnishing all equipment, labor, and materials to install, operate, maintain, and remove the dewatering system will be included in the unit pricing of the Bid Schedule items. No additional payment or compensation will be made to the Contractor.

#### 1.06 TRAFFIC CONTROL

- A. When construction takes place near traveled roadways, adequate provision shall be made for the protection of the traveling public. All work shall be planned and carried out so that there will be the least possible inconvenience to the public. The Contractor shall not block any of the roadways or driveways during construction. Traffic warning signs shall be placed with flags, and flaggers employed as required by the work, in accordance with the requirements from the *Manual on Uniform Traffic Control Devices for Streets and Highways*, latest revision.
- B. If required by the city within which the work is located or Solano County, a Traffic Control Plan shall be prepared by the Contractor, and submitted to the agency for approval. A copy of the approved plan must be submitted to the Engineer.

- C. All costs associated with the preparation and implementation of the Traffic Control Plan or warning devices shall be at the Contractor's expense. No separate payment will be made for these provisions, unless listed as a separate line item in the Bid Schedule.

#### 1.07 EXPLOSIVES

- A. Explosives will not be permitted for any work unless specifically approved, in writing, by the District.

#### 1.08 MEASUREMENT AND PAYMENT

- A. The Bid Schedule shall establish the unit costs for work items, which shall include all labor and materials necessary to construct the pay items. Unit prices stated in the Bid Schedule shall include all labor, materials and equipment required to furnish, assemble, install and adjust the work included in each Bid Item. All work and materials called for in the referenced specification, the Drawings and the Standard Details shall be included in the bid unit price.
- B. Traffic control, cleanup, guaranty, maintenance, and all labor and materials for which there is no item in the Bid Schedule, shall be project inclusive in the Bid Schedule items, and no separate, additional payment will be made therefor. All applicable State, Federal and Local taxes shall also be included.
- C. Upon award of the Contract to the Contractor, the Contractor shall submit a Schedule of Values to be used in partial payment calculations, if the Contractor wishes to use sub-items or different units of measure than are shown in the Bid Schedule. The Schedule of Values shall be subject to the approval of the District. In no case shall payments to the Contractor exceed the values set forth in the Bid Schedule.

### **PART 2 MATERIALS**

#### 2.01 MATERIALS SUPPLIED BY THE CONTRACTOR

- A. All materials shall be new and of a good quality. The Contractor shall, if required, furnish satisfactory evidence to the District as to the kind and quality of the materials.

### **PART 3 EXECUTION**

Not used.

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## SECTION 01570

### TEMPORARY EROSION and SEDIMENT CONTROL

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Temporary erosion and sediment control measures to be exercised by the Contractor as necessary to stabilize disturbed areas and prevent storm water pollution.

##### 1.02 RELATED SECTIONS

- A. Section 01100 – General Requirements
- B. Section 02200 – Site Preparation
- C. Section 02300 – Earthwork

##### 1.03 SUBMITTALS

- A. The Contractor shall submit a Notice of Intent and prepare a Storm Water Pollution Prevention Plan (SWPPP) for the project, as required.
- B. The Contractor shall submit, for approval, three (3) copies of a plan or program for erosion and sediment control.
  - 1. The proposed plan or program shall indicate complete design and construction details and locations of all proposed temporary control structures, barriers, berms, sediment retention basins, and any other salient features.
    - i. Notes, sketches and comments on a District approved Improvement Plans may be acceptable.
  - 2. Approval of the Contractor's proposed plan or program shall not relieve the Contractor of responsibility for designing, constructing, operating and maintaining erosion and sediment control facilities in a safe and systematic manner, and for repairing any damage to the control structures and equipment caused by floods or excessive storm runoff or other unforeseen circumstances.

##### 1.04 PAYMENT

- A. If installed, the erosion control straw wattles or other approved sediment traps shall be paid for at the applicable lump sum price bid therefore in the schedule.

This price shall include the preparation of submittals and plans required in section 1.03 above, the cost of installing, maintaining and removing at the conclusion of construction all temporary diversion berms, straw wattles, and/or other sediment traps, and all other work and materials required to prevent the discharge of all erosion and construction pollution products into drainage systems.

## **PART 2 MATERIALS**

### **2.01 GENERAL**

- A. The Contractor shall be responsible to provide all materials required to properly install and maintain the approved erosion and sediment control, as outlined in their plan or program.

## **PART 3 EXECUTION**

### **3.01 GENERAL**

- A. The Contractor shall maintain a copy of the SWPPP or erosion and sediment control plan on the construction site during working hours.
- B. The Contractor shall prevent erosion of soil on the site and on adjacent property resulting from the construction activities.
- C. Effective erosion and sediment control measures shall be initiated prior to the commencement of clearing, excavation, or other operations that will disturb the natural protection.
- D. Work shall be scheduled to expose areas subject to erosion for the shortest possible time, and natural vegetation shall be preserved to the greatest extent practicable.
- E. Temporary storage and construction buildings shall be located, and construction traffic routed, to minimize erosion.

### **3.02 BEST MANAGEMENT PRACTICES**

- A. The Contractor shall implement the following source control Best Management Practices (BMPs), at a minimum, to prevent the discharge of erosion and construction pollution products from moving offsite:
  - 1. All Contractor fuels, oils, greases, and other petroleum products shall be stored away from existing drainage swales so that if there is any leakage of such products they shall not flow into the existing drainage system.
  - 2. All Contractor vehicles and equipment shall undergo periodic inspection and maintenance to minimize the potential of leaks or spills of oils, grease

or hydraulic fluids.

3. The Contractor shall prevent excavated soil piles from eroding and sedimentation from flowing into an existing drainage system. Prior to the first fall rains, the Contractor shall install straw wattles, or other sediment traps, as approved by the Engineer, to prevent the increase in sediment load from flowing into the existing drainage system.
4. The Contractor shall properly implement and maintain the erosion control facilities during the duration of the rainy season and/or the project. The Engineer or his representative will make pre- and post storm inspections to assure the BMPs have functioned adequately and whether additional modification to the BMPs is required to address storm erosion issues. The Contractor shall take all responsible steps to modify and improve the installed erosion control facilities as required.
5. Stockpiled soils shall be sprayed with water to prevent blowing dust during the dry season, and unpaved graded or excavated area within the proposed construction area shall be appropriately sprayed with water each day to minimize blowing dust.
6. The construction site entry and exit locations onto paved roads shall be swept and/or washed by the Contractor as appropriate, to remove silt/sediment accumulated from construction activities. Excessive silt shall be cleaned up and hauled off. The County may require additional measures.

### 3.03 OBSERVATIONS & INSPECTIONS

- A. Representatives from the State Water Resources Control Board (SWRCB), the Regional Water Quality Control Board (RWQCB), the County or the District, upon presentation of proper credentials, shall have the right to inspect the construction site, at any time, to review storm water erosion/sediment controls in place.
- B. During and at the end of each storm event, the Contractor and the Engineer or Construction Observer/Inspector will review and determine the effectiveness of the preventative measures taken by the Contractor.
- C. The Contractor shall implement all recommendations and/or directions from the above mentioned representatives.

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## SECTION 02200

### SITE PREPARATION

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Site preparation includes clearing, grubbing, hauling and disposing of cleared material, installation and removal of temporary fencing, and all work incidental thereto.
- B. Unless otherwise noted, District forces will not prepare the rights of way for the Contractor.

##### 1.02 RELATED SECTIONS

- A. Section 01100 – General Requirements
- B. Section 02300 - Earthwork

##### 1.03 PAYMENT

- A. The payment for site preparation will be included in the applicable unit prices bid in the schedule for excavation.

#### PART 2 MATERIALS

##### 2.01 LIVESTOCK FENCING

- A. Line Posts: shall be six foot, high carbon rail steel, one and three-eighths by one and three-eighths inch tee stock, pointed for driving, with anchor plate and five fasteners.
- B. Stock wire fence: continuous 32 inches high, with 10 ga. top and bottom wires, 12½ ga. mesh wires, total eight horizontal wires. Stays shall be 12½ ga. spaced 12 in. on center. All wires shall be galvanized.
- C. Barbed wire: three strands of 12½ ga. high copper content steel wire with Class 1 galvanizing, two wires per strand, with two-point barbs 4 inches on center.
- D. Wood brace posts: heart redwood, cedar or pressure treated, 4 inch by 5 inch by 7½ feet.

## **PART 3 EXECUTION**

### **3.01 GENERAL**

- A. Approval by the District of any of the Contractor's operations or methods when clearing, grubbing and disposing of the materials shall not relieve the Contractor of its responsibilities provided for in the General Conditions.

### **3.02 CLEARING & GRUBBING**

- A. Trees interfering with the work will be pruned or removed as directed by the Engineer. Such work may require the approval of and reimbursement to the landowner.
- B. Existing improvements such as pavement, walls, buildings and hedges will be removed as directed by the Engineer.
- C. All areas of earthwork and pipe alignments shall be cleared of trees, brush, rubbish, concrete and other objectionable material, where required, in the judgement of the Engineer. The soil under all embankments shall be cleared of all stumps, roots and objectionable organic matter. Blasting will not be permitted.
- D. All clearing and preparation of the right-of-way for trenching or excavation shall be accomplished by the Contractor prior to line surveys and grade staking. The rights-of-way shall be blade-trimmed ahead of survey crews installing construction stakes.
- E. All cleared and grubbed material shall become the property of the Contractor and shall be removed from the site of the work before the date of completion, or otherwise disposed of as approved by the Engineer.

### **3.03 FENCING**

- A. Fences paralleling and interfering with installations shall be removed, and replaced in kind after completion of construction.
- B. Temporary livestock fencing will be installed where needed to accommodate landowner's livestock and where shown in the Drawings. Steel line posts shall be set and driven plumb to true line and to the depth of anchor plate, up to sixteen feet on center. Wood brace posts shall be set and tamped in auger holes, plum and in true line with line posts. Two posts and one brace post shall form a brace set. Brace sets shall be set at the beginning and end of each run, at 880 yards on center, and at every angle point. Stock wire and barbed wire shall be stretched taut by approved mechanical devices and fastened securely at each post.

/// END OF SECTION

## SECTION 02300

### EARTHWORK

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Excavation, backfill and compaction for site work, canals, pipelines and structures, channel improvements, and bank protection.

##### 1.02 DEFINITIONS

- A. **Canal excavation:** all work consistent with excavating materials from the canals and drains designated on the drawings or ordered by the Engineer, and placing the excavated materials in canal embankments, as herein specified, to form a continuation of the canal prism.
- B. **Overhaul:** a mile cubic yard of overhaul is defined as a cubic yard of excavated material hauled one mile in excess of the freehaul distance. The freehaul distance will be eight hundred feet (800').
- C. **Borrow excavation:** materials excavated for use in the construction of compacted and canal embankments and obtained from sources shown on the drawings or as designated by the Engineer. Arrangements to obtain materials from these sources, including payment of fees and royalties, will be made by the Contractor.
- D. **Structural backfill:** the process of placing earth materials about a concrete structure, moistening the material uniformly, and compacting the successive layers with hand or mechanical tamping or vibrator equipment to the required density as determined by laboratory tests.
- E. **Channel improvements:** clearing, grubbing and minor earthwork within an existing channel prism such as to provide a clear, unobstructed channel for the conveyance of drainage water.
- F. **Earth bank protection:** installing stabilizing surface coverings where natural bank protection has been destroyed by construction operations.

##### 1.03 RELATED SECTIONS

- A. Section 01100 – General Requirements
- B. Section 02200 – Site Preparation
- C. Section 02511 – Lined Canals and Reservoirs
- D. Section 02513 – Irrigation Pipelines

- E. Section 02515 – Domestic Water Systems
- F. Section 02600 – Drainage Pipelines
- G. Section 02730 – Gravel Road Surfacing
- H. Section 16010 – Basic Electrical Material and Methods, subsections 3.04 – Excavating for Electrical Work, and 3.05 – Backfilling Electrical Work.

#### 1.04 SUBMITTALS

The Contractor shall submit five copies of the following documentation:

- A. Shop Drawings in accordance with Section 00700.6.11.
- B. Trench Safety Plan in accordance with Section 00700.6.10.F.

#### 1.05 SOIL COMPACTION TESTING

- A. Cohesive materials: the density of the backfill will be a percentage of the maximum dry density as determined by Test Method ASTM D-698.
- B. Non-cohesive materials: the density of the backfill will be a percentage of the relative density as determined by Test Method ASTM D-4253. Density requirements vary depending on the type of backfill being compacted.
- C. Compaction testing will be performed by an outside agency and the results submitted to the District for approval and acceptance.

#### 1.06 MEASUREMENT & PAYMENT

- A. No separate payment will be made for excavation. The cost of all work incident thereto, including excavating, foundation preparation, placement of material in landscape areas, etc., will be included in the applicable unit prices bid in the Bid Schedule for compacted embankment.
- B. Overhaul distance will be measured in one hundred feet (100') station units along the shortest practicable route between the center of gravity of the embankment and the center of gravity of the excavation. Fractions of a station unit will be considered as a full station. Payment for overhaul will be made at the unit price per mile cubic yard bid in the schedule for overhaul.
- C. Canal Excavation: measurement for payment of canal excavation will be made in excavation by the average end area method. Prismoidal correction factors or other factors will not be used. Canal excavation will be paid for at the unit price bid per cubic yard in the schedule and shall include all cost of excavating material from canals and drains, foundation preparation, placing the materials in canal

embankments, roadway embankments or access ramps, furnishing water and wetting embankment material, finishing the canal banks, and freehaul up to eight hundred feet (800'). No additional payment will be made for re-excavated material.

- D. Payment for overhaul will be made for excavated materials required for canal embankments, and material directed to be wasted beyond the limits of freehaul.
- E. Borrow Excavation: measurement for payment of borrow excavation will be made in excavation by the average end area method. Prismoidal correction factors or other factors will not be used. Borrow excavation will be paid for at the unit price bid per cubic yard in the schedule and shall include all cost of excavating material from borrow areas, placing material in canal embankments, roadway embankments, or access ramps, furnishing water and wetting embankment material, finishing the canal banks, and freehaul up to eight hundred feet (800'). No additional payment will be made for re-excavated material.
- F. Compacted Embankments: measurement for payment for compacted embankments will be made of the volume of embankment in place, including a six inch (6") layer of the foundation for the embankment scarified as provided in subsection 3.07.B, and will include only such portions of the embankment and foundation as have been actually compacted at the direction of the Engineer. Payment for compacted embankments will be made at the unit price per cubic yard bid therefor in the Bid Schedule, which unit price will be in addition to the unit price bid in the schedule for excavating the material placed in the compacted embankments, and shall include the cost of all labor and equipment, placing the materials in layers, furnishing water, moistening, and compacting as provided in this Section.
- G. Structural Excavation and Backfill: for checks, drops and structures which form the continuation of a canal, excavation for structures will be measured below the original ground surface to the lines shown on the drawings. For structures which do not form the continuation of the canal, the excavation will include only the required excavation outside the normal canal prism between the lines shown on the drawings. Measurement will be made within these limits and shall include only the materials excavated. Excavation required for the laying of any pipe will not be considered as structural excavation. Payment for structural excavation will be included in the reinforced concrete bid item. No direct payment will be made for backfill about structures.
- H. No direct payment will be made for pipe trenching, excavating bell holes, over excavation in unsuitable materials, or for furnishing and placing select materials for bedding. All payment therefor will be included in the unit price bid in the Bid Schedule for the applicable classes and sizes of pipe.
- I. No direct payment will be made to the Contractor for backfilling pipe trenches but all payment therefor will be included in the unit price bid in the Bid Schedule for the applicable classes and sizes of pipe.

## **PART 2 MATERIALS**

### **2.01 EMBANKMENT MATERIALS**

- A. Embankments shall be built only of materials approved by the Engineer and shall be free of all roots, brush, objectionable organic matter, and rocks larger than four inches (4") in diameter.

### **2.02 BORROW EXCAVATION**

- A. All materials obtained by borrow excavation shall conform to the requirements for embankment materials. The material shall be obtained from the borrow sites shown on the Drawings or as designated by the Engineer.

### **2.03 STRUCTURAL BACKFILL**

- A. Backfill materials shall be obtained from materials removed in excavation for structures, or sources approved by the Engineer.

### **2.04 PIPE BEDDING MATERIAL**

- A. Pipe bedding is the material between the bottom of the pipe and the bottom of the trench. Bedding material shall be clean sand, three-quarter inch ( $\frac{3}{4}$ ") round rock or as directed by the Engineer.

### **2.05 TRENCH BACKFILL MATERIAL**

- A. Backfill for pipe trenches shall consist of select material and excavated material as shown on the Drawings and Standard Specification Details. Unless otherwise directed by the District, backfill placed within one foot (1') of the ground surface, and within six inches (6") of the pipe shall be free of heavy gravel, or stones greater than three inch (3") in maximum dimension, or both.
- B. Where required by the Standard Details or Drawings, pipe trenches shall be backfilled with aggregate base conforming to CALTRANS Section 26 for Class 2 Aggregate Base.

### **2.06 RIPRAP**

- A. Concrete for concrete riprap shall be three and one-half sack dry-mix concrete with maximum  $1\frac{1}{2}$  inch aggregate.
- B. Sack riprap shall be 80 pound commercially available products such as QUIKRETE Rip Rap with biodegradable bags, or approved equal.
- C. Stone riprap shall be engineer rock, broken concrete is not acceptable, and shall be one foot (1') average dimension, or as directed by the Engineer. Rip rap and gravel materials may be obtained from any source approved by the Engineer.

## 2.07 ARTIFICIALLY-SOWN BANK PROTECTION

- A. Artificially sown bank protection shall consist of grass seed and willow shoots planted by hand.
- B. Woven jute mats shall be tied in a mesh of 4 inch squares.

## PART 3 EXECUTION

### 3.01 GENERAL

- A. Excavation may be made by equipment optional to the Contractor insofar as the neat uniform excavation lines shown on the Drawings are maintained. Excavation shall be performed to the lines and grades established by the Engineer. The grading and trimming operation shall be formed by motor grader equipment and performed simultaneously with the excavation.

### 3.02 CANAL EXCAVATION.

- A. Canal excavation may be made by dragline, carryall, ditcher or other equipment optional to the Contractor insofar as the neat uniform excavation lines shown on the Drawings are maintained, and insofar as the embankment construction shall conform to the requirements of subsection 3.08.
- B. The canals shall be excavated to the full depth and widths shown on the drawings and finished uniformly to the lines and grades established by the Engineer except where, during the progress of the work, the Engineer directs the Contractor to change the side slopes. Any increase in excavation quantities as a result of changing the side slopes of the canals beyond the slopes shown on the drawings will be performed at the unit price per cubic yard named in the schedule for canal excavation.
- C. Runways for excavation equipment shall not be cut into canal slopes below the design water level. Runways above design water level into the finished canal prism shall be spaced not less than five hundred feet (500') apart. Uncontrolled travel up and down interior slopes of finished canal prisms by construction equipment will not be permitted.

### 3.03 DRAIN EXCAVATION

- A. In connection with excavation for canals, the Contractor shall perform excavation for drains to the lines and grades established by the Engineer. The Contractor will not be required to use a motor grader in the trimming of such excavation.
- B. Movement of earth shall proceed in an orderly sequence and shall be insofar as practicable in accordance with the mass diagram. Any deviation from the mass diagram shall be subject to prior approval of the Engineer.

- C. Material excavated from drains will be used in the canal embankments, or as directed by the Engineer. Except as otherwise specified, all suitable materials removed in canal or structure excavation or as much thereof as may be needed shall be used in the construction of canal embankments, roadway embankments, access ramps to bridges and canal banks, or about structures as directed by the Engineer. If there is an excess of material in the excavation, it shall be used to strengthen the embankment of the canals as may be directed.

### 3.04 BORROW EXCAVATION

- A. Excavation shall be performed to the lines and grades established by the Engineer. Upon completion of borrow operations, borrow pits shall be left in a reasonably smooth, even, free draining condition. The Engineer will so direct the Contractor when borrow excavation is to be utilized. Where rock surfaced roadways exist through the borrow area, the existing rock surfacing shall be salvaged for reuse as directed by the District.

### 3.05 STRUCTURAL EXCAVATION.

- A. Materials excavated for structures will not be classified for payment.
- B. Where, in the judgment of the Engineer, the stability of the earth materials is such that it can be trimmed to the required lines of the concrete, the concrete may be placed against the excavation without intervening forms. Where the character of the earth material is such that forming is required, the site will be excavated beyond the neat lines on the drawings and the structure formed as provided for in Section 03300 – Cast-in-Place Concrete or Section 03315 – Structural Concrete.
- C. The bottom and side slopes or excavation upon or against which concrete is to be placed shall be finished accurately to the dimensions shown on the drawings or prescribed by the Engineer. If, at any point, material is excavated beyond the neat lines required to receive the structure or the natural foundation is disturbed or loosened during the excavation process, the foundation for the structure shall be brought back to grade and consolidated in a manner satisfactory to the Engineer.

### 3.06 EXCAVATION AND FOUNDATIONS FOR CONCRETE PIPE STRUCTURES

- A. The excavation shall be sufficient to provide adequate space for the proper banding and handling of the pipe sections.
- B. If the natural foundation for the structure is disturbed or loosened during the excavation process, the Contractor shall compact the foundation to the density specified in subsection 3.10. The bottom of the excavation shall be excavated to a minimum of one foot (1') below the required neat line of the structure.
- D. When water is encountered in the excavation, it shall be removed by pumping or draining. The foundation excavation shall be refilled with six inch (6") layers of

1½” crushed rock and compacted to the density specified in subsection 3.10.

### 3.07 COMPACTED EMBANKMENTS

- A. Embankments shall be constructed as herein specified to the full height and width shown on the Drawings or as directed by the Engineer. The ground surface shall be graded to slope as shown on the Drawings.
- B. The entire surface of the foundation for embankments shall be scarified or plowed to a depth of not less than six inches (6"). In order to secure an adequate foundation and bond, the foundation material shall have the optimum practicable moisture content. If necessary to obtain the required moisture content, the Contractor shall add water.
- C. The grading, trimming, and leveling operation shall be performed by motor grader equipment, operating simultaneously with the placing of embankments.
- D. Materials to be compacted shall be deposited in horizontal layers of not more than six inches (6") thick.
- E. Prior to and during compaction, the materials shall have the optimum practicable moisture content required for the purpose of compaction and the moisture shall be uniform throughout each layer. Insofar as is practicable, moistening the material shall be performed at the site of excavation, but such moistening shall be supplemented by sprinkling at the site of compaction if necessary. If the moisture content is less than optimum for compaction, the compaction operations shall not proceed, except with the specific approval of the Engineer. If the moisture content is greater than optimal for compaction, the compaction operations shall be delayed until such time as the material has dried to the optimum practicable moisture content, and no adjustment in price will be made on account of any operation of the Contractor in drying the materials or on account of delays occasioned thereby.
- F. When the material has been conditioned as specified in subsection 3.07.E, it shall be compacted by sheepsfoot rollers of sufficient weight for proper compaction, or other equipment approved by the Engineer. See subsection 3.10 for required compaction levels.

### 3.08 CANAL EMBANKMENTS

- A. Canal embankments shall be constructed as herein specified to the cross section shown on the Drawings or as directed by the Engineer. The ground surface at the top of bank of all canals shall be graded to slope away from the canal as shown on the Drawings. The Contractor shall slope the ground surface simultaneously with canal finish so as to provide continuous protection against erosion of the interior canal prism.
- B. The entire surface of the foundation for canal embankments shall be scarified or

plowed to a depth of not less than six inches (6"). In order to secure an adequate foundation and bond for canal embankments, the foundation material shall have the optimum practicable moisture content. If necessary to obtain the required moisture content, the Contractor shall add water.

- C. Wheel-Rolled Canal Embankments: The construction procedure used for wheel-rolled canal embankments will be by one of the following methods:
1. When the embankment is made with wheeled scrapers or other hauling equipment the fill shall be leveled off in uniform lifts eight inches (8") thick and the equipment shall be so routed as to provide for maximum coverage of the surface area by the wheels. Special care shall be exercised to obtain proper moisture control and compaction at the interior trim line of the canal prism.
  2. When a Briscoe Pitcher or dragline is used, a wheel-compacted pad shall be constructed to the required elevations and sections. The canal shall then be constructed to lines and grades shown on the drawings.
  3. Travel of the construction equipment shall be so routed over the layers of earth material to distribute the compacting effect to the best advantage. In the event adequate compaction is not obtained in the placing of the material by passage of the hauling equipment over the material, the Engineer may require additional compaction as provided for in subsection 3.07.D.
- D. Compacted Canal Embankments
1. Where shown on the drawings or directed by the Engineer, the Contractor shall compact canal embankments over and above the compaction obtained by the methods set forth in subsection 3.08.C.
  2. Where compacting of cohesive earth materials is required, the materials shall be deposited in horizontal layers of not more than six inches (6") thick.
  3. When the material has been conditioned as specified in subsection 3.08.E, it shall be compacted by sheepsfoot rollers of sufficient weight for proper compaction, or other equipment approved by the Engineer.
  4. See Section 3.10 for required compaction levels.
- E. Prior to and during compaction, the embankment materials shall have the optimum practicable moisture content required for the purpose of compaction, and the moisture shall be uniform throughout each layer. Insofar as practicable, moistening of the material shall be performed at the site of excavation, but such moistening shall be supplemented by sprinkling at the site of compaction, if necessary. If the moisture content is less than optimum for compaction, the compaction operations shall not proceed, except with the specific approval of the Engineer, and if the moisture content is greater than optimum for compaction, the compaction operations shall be delayed until such time as the material has dried to the optimum practicable moisture content, and no adjustment in price will be made on account of any operation of the Contractor in drying the materials or on

account of delays occasioned thereby.

- F. The grading, trimming, and leveling operation shall be performed by motor grader equipment, operating simultaneously with the placing of embankments. The finer portions of the material shall be deposited in or graded to the section of the canal embankment next to the canal prism.

### 3.09 STRUCTURAL BACKFILL

- A. The Contractor shall place backfill about all structures in six inch (6") layers to the lines shown on the drawings or prescribed by the Engineer. Backfill shall be compacted up to natural ground or finished canal section, unless otherwise shown on the drawings, or as directed by the Engineer, about all structures.
- B. Backfill may be placed against concrete structures after the concrete has reached a compressive strength of 3,000 psi. In the event the Contractor desires to undertake the backfill of a structure before it has reached the recommended compressive strength, this may be done provided that temporary strutting or bracing is installed within the structure as a protection against possible damage. These struts shall be left in place until the concrete has reached the compressive strength of 3,000 psi.
- C. Where applicable, subsection 3.07 shall govern backfilling about structures.
- D. See subsection 3.10 for required compaction levels.
- E. Excess material from structural excavation shall be disposed of by the Contractor at its expense.

### 3.10 COMPACTION LEVELS

- A. Refer to subsection 1.05 for required compaction test methods. Compaction testing will be performed by the Engineer.
- B. Embankments: The following compaction standards shall be met in embankments:
  - 1. Compacted embankments, cohesive materials: dry density of not less than ninety percent (90%) of the laboratory standard maximum soil dry density.
  - 2. Compacted embankments, cohesionless materials: dry density of not less than seventy percent (70%) of the relative dry density.
  - 3. Canal embankments, cohesive materials: dry density of not less than ninety percent (90%) of the laboratory standard maximum soil dry density.
  - 4. Structural backfill, cohesive materials: dry density of not less than ninety five percent (95%) of the laboratory standard maximum soil dry density.

5. Structural backfill, cohesionless materials: dry density of not less than seventy percent (70%) of the relative dry density.
- C. Trench Backfill: The required density of cohesive backfill will be a percentage of the maximum dry density as determined by ASTM D-1557 and as shown on the Drawings and the Standard Specification Details.

### 3.11 FINISH AND TOLERANCE

- A. In canal sections of full cut, the Contractor shall finish side slopes immediately behind each three foot (3') increment of canal depth, more or less, to prevent loss of moisture content in the exposed soil prior to finishing, and to provide adequate control of slope and alignment. In sections of partial or full canal embankment, the Contractor shall so coordinate his finishing operations as to insure the movement of earth in accordance with the mass diagrams. Trimming shall be performed while the earth is at optimum moisture content in accordance with subsection 3.07.E.
- B. Site surfaces and exterior bank slopes shall be trimmed to lines and grades by a motor grader if practicable.
- C. Excavation finished elevations shall be within 0.1 feet of those staked. Embankment finished elevations shall be within 0.05 feet of those staked.

### 3.12 TRENCHING FOR PIPE

- A. General: At all times the Contractor shall follow the Trench Safety Plan and all applicable OSHA requirements. Before pipe is laid the trench alignment, grade, bottom and bedding shall be properly established, and shall be inspected by the District to conform to the District's standards.
- B. Grade, Alignment and Dimension: The alignment and grade for the bottom of the trench shall be properly established before the trench is excavated. Trenches shall be dug true to line and grade, and the bottom of the trench shall be smooth and free from all objectionable material. The sides of the pipe trench shall be excavated vertically to the top of the pipe where the Trench Safety Plan and the stability of the soil will permit. The trench shall be sufficiently wide to properly perform the necessary laying, handling and joining operation. There shall be a minimum clearance of not less than six inches (6") on each side of the pipe. The trench width shall be sufficient to accommodate hand-held backfill tampers or vibrating equipment on both sides of the pipe, but shall not be more than twenty four inches (24") greater than the external diameter of the pipe barrel, except at bell holes. Trench excavation which, in the judgement of the District, is excessively wide or non-uniform will not be permitted.
- C. Trench in Soft or Unstable Material: Where the bottom of the trench is soft and unstable, it shall be excavated a minimum of one foot (1') below grade for the full

width of the trench to firm material. When the bottom of the trench is excavated below grade, the overexcavation shall be refilled and consolidated with rock of one and one half inches (1½") maximum size, with a gradation approved by the Engineer.

- D. Trench in Rock or Boulders: If the trench is excavated in rock, boulders or other hard material that cannot be excavated by the normal trenching methods, the bottom of the trench shall be excavated six inches (6") below the required grade for the full width of the trench, refilled with select material approved by the Engineer, and compacted in accordance with the applicable provisions of subsection 3.13, below.
- E. Trench Condition Before Laying Pipe: All surfaces against which the pipe is to be placed shall be free of standing water, loose earth, mud and debris. Should water get into the trench before the pipe is laid, the laying of the pipe shall be postponed until the trench has been drained or pumped, and dried sufficiently to provide a firm foundation for the pipe, or the mud or soft material shall be removed and the grade reestablished by refilling as specified above.
- F. Pipe Bedding: Immediately before placing each section of the pipe, the pipe bedding shall be prepared to provide uniform bearing along the full length of the pipe except at bell holes. Depth of bedding shall be as shown in the Standard Details. A bell hole shall be excavated under and immediately in front of the last section of pipe which has been laid. The bell hole shall provide a minimum clearance between the pipe barrel and bottom of the bell hole of three inches (3") but in no case shall the bell holes be smaller than required to facilitate joining or laying the pipe.

### 3.13 BACKFILL OF PIPE

- A. General: Unless otherwise directed or approved, the Contractor shall backfill the trench prior to field testing and within 48 hours after the time the pipe has been installed. Thrust blocks and concrete-joined bends shall not be backfilled prior to twenty-four (24) hours after the concrete is placed. Regardless of the method and materials used in backfilling the pipe trench, the Contractor shall be responsible for avoiding damage to the pipe, and coatings if any. The pipe shall not be displaced from alignment during the backfilling operation. The Contractor shall take all precautions necessary to prevent water flooding the trench before the backfill is complete.
- B. Placement of Backfill
  - 1. Backfill shall not be dropped directly on the pipe. Backfill shall be placed at approximately the same elevation on both sides of the pipe. The Contractor shall use extreme care in placing the backfill under the pipe haunches to assure that all spaces are filled under and about the pipe.
  - 2. Where the backfill is of cohesive materials the materials shall be deposited in horizontal layers of not more than eight inches (8") thick.

3. Prior to and during compaction, the materials shall have the optimum practicable moisture content required for the purpose of compaction and the moisture shall be uniform throughout each layer. If the moisture content is less than optimum for compaction, the compaction operations shall not proceed, except with the specific approval of the Engineer and, if the moisture content is greater than optimum for compaction, the compaction operations shall be delayed until such time as the material has dried to the optimum practicable moisture content, and no adjustment in price will be made on account of any operation of the Contractor in drying the materials or on account of delays occasioned thereby.
- C. Excess Material: Material excavated from the trench over and above the quantity required to fill the trench shall be neatly heaped over the pipe along its length except that in roadways or crossings the material shall be disposed of as directed by the Engineer.
- D. Compaction: When the material has been conditioned as specified in subsection 3.13.b.3, it shall be compacted by equipment approved by the Engineer. The Contractor shall use extreme care in compacting the backfill in the vicinity of the pipe to avoid damage to the pipeline. The degree of compaction required depends on the location to be compacted, as shown in the Drawings and the Standard Specifications Details. The compaction requirements are shown in the Standard Details. Test methods used shall conform TO the requirements of this Section. Initial backfill compaction testing shall be at the District's expense, but retesting shall be at the Contractor's expense.
- E. Sheeting Removal: Where the side walls of the trench are unstable or where the depth of the trench will present a safety hazard to workers and the Contractor has elected to use sheeting, it shall be withdrawn as the backfill is placed about the pipe. Any voids which result from the withdrawn sheeting shall be backfilled and compacted to the same density as the remainder of the trench.
- F. Roadway Crossings: Resurface as shown in the District's Standard Specification Details latest revision. Where the pipeline crosses county roadways, the resurfacing of the roadway shall conform to the requirements of the Solano County Transportation Department. Where the pipeline crosses city roadways, the resurfacing of the roadway shall conform to the requirements of the city having jurisdiction.

#### 3.14 CHANNEL IMPROVEMENTS

- A. Trees and brush may be cut, removed at ground line and properly disposed of by the Contactor or as directed by the Engineer.
- B. The cut stumps of growth removed shall be treated chemically to inhibit further growth.

- C. Minor accumulations of silt or channel obstructing earth dams shall be removed and spread on channel banks.
- D. The District will designate rights of way to be used by clearing equipment. Maximum care shall be used to confine equipment to operation only within such rights of way.
- E. Applicable paragraphs of Solano Irrigation District Standard Specifications shall govern the various portions of the work.

### 3.15 EARTH BANK PROTECTION

#### A. Riprap

1. General: The Contractor shall place riprap for the protection of the side slopes of embankments and the bottom and side slopes of channels and around structures where shown on the drawings and elsewhere, where such protection is directed by the Engineer. The requirement for placing riprap at any point and the amount thereof will be optional with the Engineer.
2. Concrete Riprap: The riprap sacks shall be placed with the first course set end to end below the invert of the ditch or finished grade. Subsequent courses shall be placed in a running bond such that each bag overlaps the previous course by 1/3 and laid into the bank to follow the slope. Depending on the height, #3 rebar rods driven down through the courses may be required. Placement and configuration shall be as directed by the Engineer.
3. Stone Riprap: Stone riprap shall be placed to the prescribed lines and grades and thickness. Stone riprap need not be hand placed, but shall be dumped and smoothed in such a manner as to insure that the completed riprap is stable, without tendency to slide, and so that there will be no unreasonably large unfilled spaces within the riprap. The inclusion of rock spalls or gravel in the mass in an amount required to fill the voids in the material will be permissible.

- B. Artificially-Sown Bank Protection: Plant by hand where natural bank protection has been destroyed by construction operations. Such plantings shall be protected by a layer of straw, in turn held in place by a woven jute mat. The jute shall be held in place by 3/8 inch round or square wooden dowels, 12 inches long, 6' 0" on center spacing.

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## SECTION 02246

### HORIZONTAL DIRECTIONAL DRILLING

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. The work specified in this section consists of furnishing and installing an underground irrigation pipeline using the horizontal directional drilling (HDD) method of installation, also commonly referred to as directional boring or guided horizontal boring. This work shall include all services, equipment, materials, and labor for the complete and proper installation, testing, restoration of underground utilities and environmental protection and restoration.
- B. This specification is primarily written for the installation of high density polyethylene (HDPE) pipelines. For the installation of other materials such as fusible C-905 PVC or welded steel, the methods and specifications herein apply, but may be modified by the Engineer as appropriate.
- C. The size and configuration of the various components of the water system shall as indicated herein, in the Standard Details, and in the approved Improvement Plans, if any.
- D. All materials and installation of the system shall be in accordance with the standards and specifications of Solano Irrigation District, latest revision.

##### 1.02 RELATED SECTIONS

- A. Section 01100 – General Requirements
- B. Section 02514 – Gravity Irrigation Pipelines (PVC)
- C. Section 02515 – Pressurized Non-Potable Water Systems
- D. Section 02516 – Domestic Water Systems
- E. Section 02517 – High Density Polyethylene (HDPE) Pipe and Fittings

##### 1.03 QUALIFICATIONS

Directional drilling and pipe installation shall be done by an experienced Contractor specializing in directional drilling and whose key personnel have at least five (5) years experience in this work. Furthermore, the Contractor must have installed directionally drilled pipe at least as large as 20 inches in diameter, having performed installations of at least 1,000 feet in length, and successfully installed at least 50,000 feet in total length.

#### 1.04 QUALITY ASSURANCE

This specification calls for a wide range of procedural precautions necessary to insure that the very basic, essential aspects of a proper directional bore installation are adequately controlled. Strict adherence shall be required under specifically covered conditions outlined in this specification. Adherence to the specifications contained herein, or the Engineer's approval of any aspect of any directional bore operation covered by this specification, shall in no way relieve the Contractor of their ultimate responsibility for the satisfactory completion of the work authorized by the District.

#### 1.05 SUBMITTALS

- A. WORK PLAN: Prior to beginning work, the Contractor must submit to the Engineer a general work plan outlining the procedure and schedule to be used to execute the project. The plan should document the thoughtful planning required to successfully complete the project.
- B. EQUIPMENT: The Contractor must submit specifications on directional drilling equipment to be used to ensure that the equipment will be adequate to complete the project.
- C. LABOR: The Contractor must submit a detailed list of supervisory, technical and general personnel to be utilized during the project. Certifications and experience of all key personnel must be included.
- D. MATERIALS: Specifications on all materials to be used shall be submitted to the Engineer for approval. Materials shall include the pipe, fittings and any other item which is to be an installed component of the project.
- E. OTHER: All other permits and/or plans required of the Contractor by the District, County or affected agency including, but not limited to, temporary erosion & sediment control plan, dewatering plan, traffic control plan and trench shoring plan.
- F. SOLANO PROJECT FACILITIES: All projects involving the facilities of the Solano Project (i.e. Putah South Canal), must follow the additional requirements set by United States Bureau of Reclamation as stated in Section DS11 – Development Requirements Involving Facilities of the Solano Project.

#### 1.06 MEASUREMENT AND PAYMENT

- A. Pipelines shall be paid for at the unit price per foot bid in the Bid Schedule. Payment shall include installed pipe, fittings, specials, bends, connections, tracer wire, potholing, boring and receiving pits, dewatering, shoring, bracing, concrete thrust blocks, backfill, compaction, testing, permits, inspection, cleanup, guaranty, maintenance and all other labor and materials required to construct the pipelines.

- B. Valve installation will be paid for at the applicable unit price bid therein in the Bid Schedule. The unit price shall include all materials and labor, including valve access wells where required, fabricating, furnishing trenching, placing, backfilling, companion flanges, bolts, nuts & washers, testing, guaranty, maintenance, and all work required to complete the valve installation.
- C. Air and Vacuum and Blow Off Valves will be paid for at the applicable unit price each as bid in the Bid Schedule. Said price shall include all materials and labor, valves, pipe well and lid, piping, ball valves, fabricating, furnishing, installing, gravel backfill, guaranty, maintenance, and all other labor and materials required to complete the installation.
- D. All labor, equipment and materials for which there is no item in the Bid Schedule shall be included in the unit price bid for the applicable size of pipe to which they are appurtenant.

## **PART 2 MATERIALS**

2.01 The material requirements for the pipe and fittings shall be as required in Section 02517 – High Density Polyethylene (HDPE) Pipe and Fittings. All other pipe and fitting materials shall be as required by the Contract Documents or shown on the Drawings.

### **2.02 EQUIPEMENT**

- A. General: The directional drilling equipment shall consist of a directional drilling rig of sufficient capacity to perform the bore and pullback of the pipe, a drilling fluid mixing & delivery system of sufficient capacity to successfully complete the installation, a guidance system to accurately guide boring operations, and trained and competent personnel to operate the system. All equipment shall be in good, safe operating condition with sufficient supplies, materials and spare parts on hand to maintain the system in good working order for the duration of this project.
- B. Drilling Rig: The directional drilling machine shall consist of a hydraulically powered system to rotate, push and pull hollow drill pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill (bore) head. The machine shall be anchored to the ground to withstand the pulling, pushing and rotating pressure required to complete the crossing. The hydraulic power system shall be self-contained with sufficient pressure and volume to power drilling operations. The hydraulic system shall be free of leaks. The rig shall have a system to monitor and record maximum pull-back pressure during pull-back operations.
- C. Drill Head: The drill head shall be steerable by changing its rotation and shall provide the necessary cutting surfaces and drilling fluid jets.
- D. Mud Motors (if required): Mud motors shall be of adequate power to turn the required drilling tools.

- E. Drill Pipe: Shall be constructed of high quality 4130 seamless tubing, grade D or better, with threaded box and pins. Tool joints should be hardened to 32-36 RC.

## 2.03 GUIDANCE SYSTEM

- A. The guidance system shall be of a proven type and shall be setup and operated by personnel trained and experienced with this system. The Operator shall be aware of any magnetic anomalies and shall consider such influences in the operation of the guidance system if using a magnetic system.

## 2.04 DRILLING FLUID (MUD) SYSTEM

- A. Mixing System: A self-contained, closed, drilling fluid mixing system shall be of sufficient size to mix and deliver drilling fluid composed of bentonite clay, potable water and appropriate additives. Mixing system shall be able to molecularly shear individual bentonite particles from the dry powder to avoid clumping and ensure thorough mixing. The drilling fluid reservoir tank shall be sized for adequate storage of the mud. Mixing system shall continually agitate the drilling fluid during drilling operations.
- B. Drilling Fluids: Drilling fluid shall be composed of clean water and an appropriate additive. Water shall be from a clean source with a pH of 8.5 – 10 and/or as per mixing requirements of the manufacturer. Water of a lower pH or with excessive calcium shall be treated with the appropriate amount of sodium carbonate or equal. The water and additives shall be mixed thoroughly and be absent of any clumps or clods. No hazardous additives may be used. Drilling fluid shall be maintained at a viscosity sufficient to suspend cuttings and maintain the integrity of the bore wall.
- C. Delivery System: The mud pumping system shall have a minimum capacity to supply mud in accordance with the drilling equipment pull-back rating at a constant required pressure. The delivery system shall have filters in-line to prevent solids from being pumped into the drill pipe. Connections between the pump and drill pipe shall be relatively leak-free. Used drilling fluid and drilling fluid spilled during drilling operations shall be contained and properly disposed of. A berm, minimum of 12 inches (12”) high, shall be maintained around drill rigs, drilling fluid mixing system, entry and exit pits and drilling fluid recycling system (if used) to prevent spills into the surrounding environment. Pumps and/or vacuum truck(s) of sufficient size shall be in place to convey excess drilling fluid from containment areas to storage facilities.

## 2.05 OTHER EQUIPMENT

- A. Pipe Rollers: Pipe rollers, if required, shall be of sufficient size to fully support the weight of the pipe while being hydro-tested and during pull-back operations. Sufficient number of rollers shall be used to prevent excess sagging of pipe.
- B. Pipe Rammers: Hydraulic or pneumatic pipe rammers may only be used if

necessary and with the authorization of the Engineer.

- C. Restrictions: Other devices or pipeline placement systems for providing horizontal thrust other than those previously defined in the preceding subsections shall not be used unless approved by the Engineer prior to the commencement of the work. Consideration for approval will be made on an individual basis for each specified location. The proposed device or system will be evaluated prior to approval or rejection on its potential ability to complete the pipeline placement satisfactorily without undue stoppage and to maintain line and grade within the tolerances prescribe by the particular conditions of the project. Approval by the Engineer does not relieve the Contractor of its responsibilities (see section 1.04)

## **PART 3 EXECUTION**

### **3.01 GENERAL**

- A. The Engineer must be notified 48 hours in advance of starting work. The directional bore shall not begin until the Engineer or his authorized representative is present at the job site and agrees that proper preparations and precautions for the operation have been made. The Engineer's approval for beginning the installation shall in no way relieve the Contractor of the ultimate responsibility for the satisfactory completion to the work as authorized under the Contract. It shall be the responsibility of the District to provide inspection personnel at such times as appropriate without causing undue hardship by reason of delay to the Contractor.

### **3.02 PERSONNEL REQUIREMENTS**

- A. All personnel shall be fully trained in their respective duties as part of the directional crew and in safety.

### **3.03 DRILLING PROCEDURE**

- A. Site Preparation:
1. Prior to any alterations to the work-site, the Contractor shall photograph or video record the entire work area, including entry and exit points. One copy of which shall be given to the Engineer and one copy shall remain with the Contractor for a period of one year following the completion of the project.
  2. The work site as indicated on the Drawings, within the right-of-way, shall be graded or filled to provide a level working area. No alterations beyond what is required for operations are to be made. The Contractor must confine all activities to the designated work areas.
- B. Drill Path Survey: The entire drill path shall be accurately surveyed with entry and exit stakes placed in the appropriate locations within the areas indicated on

the Drawings. If the Contractor is using a magnetic guidance system, the drill path will be surveyed for any surface geomagnetic variations or anomalies.

- C. Environmental Protection: The Contractor shall place silt fence between all drilling operations and any drainage, wetland, waterway or other area designated for such protection by the Contract Documents, state, federal and local regulations. Additional environmental protection necessary to contain any hydraulic or drilling fluid spills shall be put in place, including berms, liners, turbidity curtains and other measures. The Contractor shall adhere to all applicable environmental regulations. Fuel or oil may not be stored in bulk containers within two hundred feet (200') of any water-body or wetland.
- D. Safety: The Contractor shall adhere to all applicable state, federal and local safety regulations and all operations shall be conducted in a safe manner. Safety meetings shall be conducted at least weekly with a written record of attendance and topic submitted to the Engineer.
- E. Pipe: The pipe shall be welded/fused together in one length, if space permits. Steel pipe welds will be X-rayed prior to being placed in bore hole. Pipe will be placed on pipe rollers before pulling into bore hole with rollers spaced close enough to prevent excessive sagging of pipe.
- F. Pilot Hole:
1. Pilot hole shall be drilled on bore path with no deviations greater than 5% of depth over the length of 100 feet. In the event that the pilot does deviate from the bore path more than 5% of depth in 100 feet, the Contractor must notify the Engineer and the Contractor may be required to pull-back and re-drill from the location along the bore path before the deviation.
  2. In the event that a drilling fluid fracture, inadvertent returns or returns loss occurs during pilot hole drilling operations, the Contractor shall cease drilling, wait at least 30 minutes, inject a quantity of drilling fluid with a viscosity exceeding 120 seconds as measured by a Marsh funnel and then wait another 30 minutes. If mud fracture or returns loss continues, the Contractor must cease operations and notify the Engineer. The Engineer and Contractor will discuss additional options and work then will proceed accordingly.
- G. Reaming: Upon successful completion of the pilot hole, the Contractor will ream bore the hole to a minimum of 25% greater than outside diameter of the pipe using the appropriate tools. The Contractor shall not attempt to ream, at one time, more than the drilling equipment and mud system are designed to safely handle.
- H. Pull-Back:
1. After successfully reaming the bore hole to the required diameter, the Contractor will pull the pipe back through the bore hole. In front of the

pipe will be a swivel to prevent torsional stresses occurring in the pipe. Once pull-back operations have commenced, operations must continue without interruption until the pipe is completely pulled into the bore hole. During pull-back operations the Contractor shall not apply more than the maximum safe pipe pull pressure at any time.

2. In the event that the pipe becomes stuck, the Contractor will cease pulling operations to allow any potential hydro-lock to subside and will then continue pulling operations. If the pipe remains stuck, the Contractor must immediately notify the Engineer. The Engineer and Contractor will discuss options and work then will proceed accordingly.

#### 3.04 PIPE TESTING

- A. The pipe shall be hydrostatically tested after joining into continuous lengths prior to installation and again after installation.
- B. The testing procedure and pressures shall be in accordance to Section 02517.3.04 with the Standard Specifications.
- C. At the completion of each successful test, erosion prevention and control measures will be used during removal and discharge of the water.

#### 3.05 DISINFECTION AND DECHLORINATION

- A. Disinfection procedure must be in accordance with Section 02516.3.11
- B. Dechlorination procedure must be in accordance with Section 02516.3.12.

#### 3.06 SITE RESTORATION

Following drilling operations and pipeline installation, the Contractor must de-mobilize equipment and restore the work-site to its original condition or as specified in the Contract Documents. All excavations must be backfilled and mechanically compacted to 95% of original density. Landscaping must be restored or replaced to its original condition. All drilling mud shall be properly disposed of by the Contractor.

#### 3.07 RECORD KEEPING

The Contractor shall maintain a daily project log of drilling operations and a guidance system log with a copy given to the Engineer at the completion of the project. As-Built drawings will be verified as to accuracy by the Engineer.

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## SECTION 02511

### CONCRETE LINED CANALS AND RESERVOIRS

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

Canal linings shall be constructed where shown on the drawings. The lining will be unreinforced concrete containing polypropylene fibers, two and one-half inches (2-1/2") thick minimum placed over a geomembrane liner, except that where placed at canal structures or shown on the drawings, the concrete lining will be reinforced. Pneumatically applied mortar lining may be substituted for concrete lining in accordance with the applicable portions of this Section, except as herein specified.

##### 1.02 RELATED SECTIONS

- A. Section 01100 – General Requirements
- B. Section 02100 – Site Preparation
- C. Section 02300 – Earthwork

##### 1.03 CONTRACTOR QUALIFICATIONS

- A. The Contractor shall provide evidence of previous construction experience on similar type pneumatically applied mortar projects if so requested by the Engineer.

##### 1.04 PAYMENT

- A. Measurement for payment of unreinforced and reinforced concrete canal lining will be made on the basis of the surface area of the lining in place. Payment will be made at the applicable unit price bid per square foot in the Bid Schedule, and shall include all work and materials required in preparing the earth foundation, placing, and curing the concrete lining, placing cut-off walls at the ends of the lined section, polypropylene fibers, furnishing and placing reinforcing steel and escape ladders, panel repair, and shall be in addition to the unit price bid in the Bid Schedule for canal excavation and compacting embankments.
- B. Measurement for payment of unreinforced and reinforced pneumatically-applied mortar canal lining will be made on the same basis provided for in subsection 1.04.A.
- C. Excavation for the concrete footings at the transitions from the canal lining to the concrete structures below the canal prism shall be as shown in the Drawings and all payment therefor will be included in the unit price bid in the Bid Schedule for

reinforced canal lining.

## **PART 2 MATERIALS**

### **2.01 CONCRETE**

- A. **CEMENT.** All cement shall be Portland cement, Type II, low alkali, and shall conform to ASTM Designation C-150. The cement shall be free of lumps and properly aged.
- B. **AGGREGATES.** Fine and coarse aggregates shall conform to the requirements of ASTM C-33. The maximum nominal size of coarse aggregate shall be  $\frac{3}{4}$  inch for concrete lining. Aggregate for air blown mortar may consist of not more than 30% pea gravel with a maximum nominal size less than  $\frac{3}{8}$  inches.
- C. **WATER.** Water shall be clean and free from oils, acids, salts, or other injurious substances.
- D. **ADMIXTURES.** The Contractor may use an air entraining agent conforming to the requirements of ASTM Designation C-260 in all concrete. The amount of air entraining agent, if used, shall be such as will affect the entrainment of four to six percent (4%-6%) of air, by volume of the concrete at the time of discharge from the mixer. The Contractor may use a pozzolan conforming to the requirements of ASTM Designation C-618 or a liquid admixture with pozzolan characteristics in accordance with ASTM Designation C-494.
- E. **FIBER REINFORCEMENT.** Polypropylene fiber filaments shall conform to ASTM C-1116. The fiber length shall be three-quarters inch ( $\frac{3}{4}$ " ). Fibers shall be added to the concrete mix at the time of batching at the rate of 2 pounds per cubic yard of concrete.

### **2.02 REINFORCEMENT**

- A. Reinforcement in reinforced concrete canal lining shall be #4 reinforcing bars conforming to Section 03300.2.05.
- B. Polypropylene fiber filaments shall conform to ASTM C-1116. The fiber length shall be three-quarters inch ( $\frac{3}{4}$ " ). Fibers shall be added to the concrete mix at the time of batching at the rate of  $1\frac{1}{2}$  pounds per cubic yard of concrete.

### **2.03 PNEUMATICALLY APPLIED MORTAR LINING**

- A. Pneumatically applied mortar shall consist of a mixture of Portland cement, sand, and water placed under pneumatic pressure. One part, by weight, of cement will be used with 4.5 parts, by weight, of surface dry sand.
- B. The Contractor shall provide such means and equipment as are required to control

accurately the relative amounts of cement, sand, and water entering the mortar. The equipment and its operation shall be subject to the approval of the Engineer.

- C. The mortar shall be proportioned on the basis of integral sacks of cement, and the amount of sand shall be determined by direct weighing. The amount of water used shall be that required to produce mortar of suitable consistency, quality, and uniformity with the minimum rebound.
- D. Fine aggregates shall conform to the requirements of ASTM C-33. Aggregate for air blown mortar may consist of not more than 30% pea gravel with a maximum nominal size less than 3/8 inches.

#### 2.04 GEOMEMBRANE

- A. Material shall be surfaced coextruded textured high density polyethylene geomembrane, 40 mil GSE White Textured (HDT 040G010), or approved equal and will have a minimum warranty of 5 years.

#### B. MINIMUM VALUES

1. Thickness (minimum average) (ASTM D 5994): 38 mil (0.96 mm)
2. Density (ASTM D 1505): 0.94 g/cm<sup>3</sup>
3. Tensile Properties, each direction (ASTM D 6693, Type IV):
  - a. Strength at Break: 60 lb/in-width (11 N/mm)
  - b. Strength at Yield: 84 lb/in-width (15 N/mm)
  - c. Elongation at Break: 100%
  - d. Elongation at Yield: 12%
4. Tear Resistance: 28 lb (125 N)
5. Puncture Resistance: 60 lb (267 N)

#### 2.05 JOINT SEALANT

- A. The adhesive sealant will be a single component high performance low modulus elastomeric sealant acceptable for a water immersion application, Sika/Sikaflex-1a or approved equal. The color of the sealant will be white or as approved by the Engineer.
- B. The joint sealant primer will be non-toxic and non-staining, Sika/Sikaflex Primer 429/202, or as recommended by the joint sealants manufacturer.
- C. The sealant backer rod will be compressible polyethylene foam rod or other flexible, permanent, durable non-absorptive material recommended by the joint sealant manufacturer and compatible with the joint sealant.

#### 2.06 ESCAPE LADDERS

- A. Ladders shall be fabricated per the Standard Details, and shall be galvanized before installation in or onto the concrete lining.

## PART 3 EXECUTION

### 3.01 EXCAVATION AND PREPARING EARTH FOUNDATION FOR CANAL LINING

- A. Excavation for canal lining shall be as provided for in the applicable portions of Section 02300 - Earthwork.
- B. Where the natural ground surface is below the elevation of the top of the canal lining shown on the drawings, the foundation for the concrete lining shall be compacted as provided for in Section 02300 - Earthwork. The Contractor shall trim and finish the earth surfaces to provide a firm foundation for the concrete lining. If, at any point, the natural foundation material is disturbed or loosened during the excavation process or otherwise, it shall be consolidated in a manner satisfactory to the Engineer. If, at any point, material is excavated beyond the neat lines required to receive the concrete, the excess excavation shall be filled with selected material, moistened, if required, and compacted in a manner satisfactory to the Engineer.
- C. Immediately prior to placing concrete, the foundation shall be thoroughly moistened.

### 3.02 GEOMEMBRANE LINING

- A. Deployment:
  - a. The geomembrane panels shall be set out in accordance with the manufacturer's recommendations and shall comply with the following guidelines.
    - i. Sandbags or approved equal shall be used for ballast and to prevent wind uplift.
    - ii. Personnel walking on the geomembrane shall not engage in activities or wear shoes that could damage the geomembrane. Smoking will not be permitted on the geomembrane.
    - iii. Heavy vehicular or equipment will not be permitted to travel directly on the geomembrane unless protective measures are followed as required by the geomembrane manufacturer.
    - iv. Sufficient material (slack) shall be provided to allow for thermal expansion and contraction of the geomembrane during installation.
- B. Field Seaming:
  - a. To the maximum extent possible, the seams shall be perpendicular to the canal unless otherwise approved by the Engineer.

- b. Slope panels shall extend a minimum of five (5) feet beyond the grade break into the flat area.
- c. Alignment of the seam overlaps shall be consistent with the requirements of the welding equipment being used. A minimum of six (6) inches of overlap is required.
- d. Welding equipment and accessories shall meet the manufacturer's recommendations and requirements.
- e. Trial welds shall be performed on geomembrane samples to verify the welding equipment is operating properly.
- f. No welding equipment or welder shall be allowed to perform production welds until the equipment and welders have successfully completed acceptable trial welds.
- g. Seaming shall not proceed when ambient air temperature or adverse weather conditions jeopardize the integrity of the liner installation.

C. Repair:

- a. Damaged geomembrane shall be removed and replaced with acceptable geomembrane material if damage cannot be satisfactorily repaired as directed by the Engineer.
- b. All patches or caps shall extend a minimum of six (6) inches for extrusion welds and four (4) inches for wedge welds beyond the edge of the defect and around all edges of the patch material.
- c. Damaged geomembrane shall be repaired using one of the following repair methods as agreed upon by the Contractor and the Engineer:
  - i. Abrading and Re-welding – used to repair a short section of seam.
  - ii. Spot Welding – used to repair pinholes or other minor, localized flaws or where the geomembrane thickness has been reduced.
  - iii. Capping – used to repair long lengths of failed seams.
  - iv. Flap Welding – used to extrusion weld the flap (excess outer portion) of a fusion weld in lieu of a full cap.
  - v. Remove the unacceptable seam and replace with new material.

### 3.03 PLACING REINFORCEMENT

- A. Reinforcement for canal linings shall be placed at 12 inches on center each way within the lining slab.
- B. Reinforcement placement shall conform to Section 03300.3.03.

### 3.04 CONCRETE HANDLING AND PLACING

- A. In preparation for the placing of concrete, all water, construction debris and extraneous matter shall be removed from the canal section. The concrete shall be placed as nearly as possible to its final position by means that avoid segregation of the materials and displacement of the reinforcement.
- B. Precautions and provisions shall be made to avoid plastic shrinkage cracking. When site and/or environmental conditions exist that have a high possibility for plastic shrinkage cracking, the Contractor shall follow these additional requirements:
  - 1. Concrete shall not be placed in conditions where wind speed is or is anticipated to exceed 15 mph or if the combination of environmental and site conditions promote plastic shrinkage cracking.
    - a. At the discretion of the Engineer, concrete placement may be halted or postpone based on the current or forecasted weather conditions.
    - b. Delays in the concrete placement shall not relieve the Contractor from completing the project by the specified completion date stated in the Contract Documents.
  - 2. A written proposal shall be submitted to the District Engineer for approval. The proposal will include the method of concrete placement, alternative mix designs, list of materials, additional finishers and laborers and equipment necessary to minimize the cracking.
    - a. Curing compound shall be applied to the surface immediately following the finishing operation and the entire surface covered with polyethylene sheeting.
    - b. Written approval does not relieve the Contractor of his or her responsibility nor accountability if plastic shrinkage cracking occurs.
  - 3. No additional compensation will be made to the Contractor

### 3.05 PLACING SLIP-FORMED CANAL LINING

- A. The lining shall be placed against undisturbed earth or compacted embankment. The type of construction will be optional to the Contractor provided that neat,

accurate, and durable concrete lining, as provided for in these specifications, is the finished product.

### 3.06 PLACING PNEUMATICALLY-APPLIED MORTAR LINING

- A. All canal gates, pumps and appurtenances shall be properly covered and protected with viscuine prior to the placement of the concrete lining.
- B. All absorptive surfaces against which pneumatically applied mortar is to be placed shall be moistened thoroughly. Free water will not be permitted on the surface during the application. Ground wires shall be installed in the canal prism to outline the finished surface of the lining as shown on the plans or as directed by the Engineer.
- C. The mortar shall be applied from a nozzle held approximately four feet (4') from the surface, and in a stream as nearly perpendicular to the surface being covered as practicable.
- D. The pressure in the placing machine shall be maintained at not less than forty-five pounds per square inch (45 psi) for hose lengths up to one hundred feet (100') and shall be increased five pounds per square inch (5 psi) for each additional fifty feet (50') of hose. Water pressure shall be maintained at least fifteen pounds per square inch (15 psi) greater than the pressure in the placing machine.
- E. Sand pockets shall be removed and replaced with pneumatically applied mortar as herein specified. Rebound shall not be incorporated in the work in any manner.
- D. Construction joints shall be sloped to a thin edge and the edge shall be thoroughly cleaned and wetted before the adjacent section of mortar is placed.

### 3.07 FINISHING CANAL LININGS

- A. The finished surface of canal lining shall be equivalent in evenness, smoothness, and freedom from rock pockets and surface voids to that obtainable by the effective use of a long-handled steel trowel. Shallow surface pitting and trowel marks are not objectionable.
- B. Deviations from true line and grade shall not exceed one-tenth foot (0.1'). There shall be no abrupt changes in section, line or grade.
- C. Transverse grooves, three-quarter inch (3/4") deep and approximate one-half inch (1/2") wide, shall be made in the concrete lining. The first groove shall be made ten feet (10') from the end of the lined section and at ten-foot intervals throughout the full length of the lined section.

### 3.08 CURING CANAL LININGS

- A. Concrete lining shall be cured by a white pigmented membrane curing compound.

Membrane curing shall be by application of a sealing compound conforming to ASTM C-309. Sealing compound shall be applied to the concrete surfaces by spraying in one coat to provide a continuous, uniform membrane over all areas.

- B. The temperature of concrete as mixed and placed shall not be less than 55°F, nor greater than 90°F. If, during day or night, the ambient temperature falls below or is predicted to fall below 40°F, concrete shall be protected from freezing during placement and curing by means of heating of materials and other approved methods, as directed by the Engineer.
- C. The concrete mix for cold weather placement shall be maintained at a minimum temperature of 55°F during placement and this minimum temperature shall be maintained for the first 72 hours of curing.
- D. The maximum temperature of concrete as placed shall be less than 90°F. When the temperature of concrete as placed may be 90°F or higher, as may be reasonably predicted from current temperatures of materials and the likelihood of rises in weather temperatures, the Contractor shall employ effective means, such as precooling aggregates and mixing water, use of ice as part of the mixing water, shading aggregates, or placing at night, as necessary, to maintain the temperature of concrete, as placed, below 90°F.

### 3.09 CONCRETE PANEL INSPECTION AND REPAIR

- A. After three days of curing, the concrete panels will be inspected by the District's Inspector. All visible cracks will be marked with a water-based spray paint and be given a rating of 0, 1, 2 or 3 based on its severity.
  - a. Rating 0 (0" to less than 1/8" in width): Crack will be monitored for thirty (30) days after the placement of the concrete. Crack will not be repaired unless it expands to a rating of 1.
  - b. Rating 1 (1/8" to less than 5/16" in width): Crack will be primed and sealed with an adhesive joint sealant. Crack will be properly prepared and primed for water immersion as directed by the joint sealant's manufacturer.
  - c. Rating 2 (5/16" to less than 1/2" in width): Crack will be repaired with properly sized and installed sealant backer rod, primer and adhesive joint sealant. Crack will be properly prepared and primed for water immersion as directed by the joint sealant's manufacturer.
  - d. Rating 3 (1/2" and greater in width): Concrete panel will be removed and replaced or repaired as directed by the Engineer.
- B. The crack shall be clean, dry, frost-free and free of oil and grease. Curing compound residue and other foreign matter must be thoroughly removed prior to the application of the joint sealant primer.

- C. The air temperature at the time of application will be between 40° and 100°F or as recommended by the sealant and primer manufacturer.
- D. All cracks shall be repaired and allowed to cure for one week prior to total water immersion.

### 3.10 ESCAPE LADDERS

- A. Ladders shall be installed in all lined canals and reservoirs at the locations and spacings shown in the Drawings. Ladders shall be embedded in the freshly placed lining before it sets.

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## SECTION 02512

### EXISTING CANAL GRADING AND CONCRETE LINING

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Excavation, grading, compaction and lining shall be constructed as shown on the drawings. The lining will be unreinforced concrete two and one-half inches (2-1/2") thick, except where placed at canal structures or as shown on the drawings. The Contractor shall furnish all work and materials, including cement, sand and coarse aggregate, water, admixtures, curing compound, polypropylene fibers, mastic, form work and other materials that may form an integral part of the concrete lining. The concrete lining shall be placed on a geomembrane liner which shall be placed against undisturbed earth, compacted embankment or existing concrete liner. The type of construction will be optional to the Contractor provided that a neat, accurate, and durable concrete lining is the finished product.

##### 1.02 CONTRACTOR QUALIFICATIONS

- A. The Contractor shall provide evidence of previous construction experience on similar types of canal concrete lining projects as required by the Contract Documents.

##### 1.03 RELATED SECTIONS

- A. Section 01100 – General Requirements

##### 1.04 SUBMITTALS

The Contractor shall submit three (3) copies of the following documentation:

- A. Materials
- B. Shop fabrication drawings
- C. Solano County Encroachment Permit (as required)
- D. Traffic Control Plan (as required)
- E. Proposed Dewatering Plan
- F. Storm Water Pollution Prevention Plan

## 1.05 SOIL COMPACTION TESTING

- A. Cohesive materials: the density of the backfill will be a percentage of the maximum dry density as determined by Test Method ASTM D-698.
- B. Non-cohesive materials: the density of the backfill will be a percentage of the relative density as determined by Test Method ASTM D-4253. Density requirements vary depending on the type of backfill being compacted. Compaction testing will be performed by the District.

## 1.06 MEASUREMENT & PAYMENT

- A. Concrete Lining: measurement for payment of unreinforced concrete canal lining will be made on the basis of the surface area of the lining in place. Payment will be made at the applicable unit price bid per square foot in the Bid Schedule, and shall include all work and materials required in preparing for, placing and curing the concrete lining, placing cut-off walls at the ends of the lined section, adding polypropylene fibers, furnishing and installing the geomembrane liner, escape ladders and panel crack repair.
  - 1. Measurement for payment of unreinforced pneumatically-applied mortar canal lining will be made on the same basis provided for in subsection 1.06.A.
- B. Crack Repair: no additional compensation will be made to the Contractor for cracks repaired in accordance with subsection 3.10 in the new concrete liner.
- C. Canal Excavation: measurement for payment of canal excavation will be made in excavated areas by the average end area method. Prismoidal correction factors or other factors will not be used. Canal excavation will be paid for at the unit price bid per cubic yard in the schedule and shall include all cost of excavating material from the canal, placing the materials in canal embankments, roadway embankments, furnishing water and wetting embankment material, finishing the canal banks, and freehaul up to eight hundred feet (800'). No additional payment will be made for re-excavated material.
  - 1. Excavation for the concrete footings at the transitions to the existing concrete structures below the canal prism shall be as shown in the Drawings and all payment therefore will be included in the unit price bid in the Bid Schedule for the canal excavation.
  - 2. The removal and haul-off of the concrete rip-rap and round rock from the canal excavation shall be included in the unit price bid in the Bid Schedule for rip-rap removal.
- D. Compacted Embankments: measurement for payment for compacted embankments will be made of the volume of embankment in place, including a

six inch (6") layer of the foundation for the embankment scarified as provided in subsection 3.07.B, and will include only such portions of the embankment and foundation as have been actually compacted at the direction of the Engineer. Payment for compacted embankments will be made at the unit price per cubic yard bid therefore in the Bid Schedule, which unit price will be in addition to the unit price bid in the schedule for excavating the material placed in the compacted embankments, and shall include the cost of all labor and equipment, placing the materials in layers, furnishing water, moistening and compacting as provided in this Section.

1. Backfilling loose material, by hand or equipment, to the finished concrete liner is not categorized as "Compacted Backfill" per the Bid Schedule. No additional compensation will be paid to the Contactor.
- E. Borrow Excavation: measurement for payment for borrow excavation will be made in excavation by the average end area method. Prismatic correction factors or other factors will not be used. Borrow excavation will be paid for at the unit price bid per cubic yard in the schedule and shall include all cost of excavating material from borrow areas, placing material in canal embankments, roadway embankments, furnishing water and wetting embankment material, finishing the canal banks, and freehaul up to eight hundred feet (800'). No additional payment will be made for re-excavated material.

## **PART 2 MATERIALS**

### **2.01 EMBANKMENT MATERIALS**

- A. Embankments shall be built only of materials approved by the Engineer and shall be free of all roots, brush, objectionable organic matter, and rocks larger than two inches (2") in diameter.

### **2.02 BORROW EXCAVATION**

- A. All materials obtained by borrow excavation shall conform to the requirements for embankment materials. The material shall be obtained from the borrow sites shown on the Drawings or as designated by the Engineer.

### **2.03 GEOMEMBRANE**

- A. Material shall be surfaced coextruded textured high density polyethylene geomembrane, 40 mil GSE White Textured (HDT 040G010), or approved equal and will have a minimum warranty of 5 years.

#### **B. MINIMUM VALUES**

1. Thickness (minimum average) (ASTM D 5994): 38 mil (0.96 mm)
2. Density (ASTM D 1505): 0.94 g/cm<sup>3</sup>
3. Tensile Properties, each direction (ASTM D 6693, Type IV):

- a. Strength at Break: 60 lb/in-width (11 N/mm)
  - b. Strength at Yield: 84 lb/in-width (15 N/mm)
  - c. Elongation at Break: 100%
  - d. Elongation at Yield: 12%
4. Tear Resistance: 28 lb (125 N)
  5. Puncture Resistance: 60 lb (267 N)

## 2.04 CONCRETE

- A. CEMENT. All cement shall be Portland cement, Type II, low alkali, and shall conform to ASTM Designation C-150. The cement shall be free of lumps and properly aged.
- B. AGGREGATES. Fine and coarse aggregates shall conform to the requirements of ASTM C-33. The maximum nominal size of coarse aggregate shall be  $\frac{3}{4}$  inch for concrete lining. Aggregate for air blown mortar may consist of not more than 30% pea gravel with a maximum nominal size less than  $\frac{3}{8}$  inches.
- C. WATER. Water shall be clean and free from oils, acids, salts, or other injurious substances.
- D. ADMIXTURES. The Contractor may use an air entraining agent conforming to the requirements of ASTM Designation C-260 in all concrete. The amount of air entraining agent, if used, shall be such as will affect the entrainment of four to six percent (4%-6%) of air, by volume of the concrete at the time of discharge from the mixer. The Contractor may use a pozzolan conforming to the requirements of ASTM Designation C-618 or a liquid admixture with pozzolan characteristics in accordance with ASTM Designation C-494.
- E. FIBER REINFORCEMENT. Polypropylene fiber filaments shall conform to ASTM C-1116. The fiber length shall be three-quarters inch ( $\frac{3}{4}$ "'). Fibers shall be added to the concrete mix at the time of batching at the rate of 2 pounds per cubic yard of concrete.

## 2.05 PNEUMATICALLY APPLIED MORTAR LINING

- A. Pneumatically applied mortar shall consist of a mixture of Portland cement, sand, and water placed under pneumatic pressure. One part, by weight, of cement will be used with 4.5 parts, by weight, of surface dry sand.
- B. The Contractor shall provide such means and equipment as are required to control accurately the relative amounts of cement, sand, and water entering the mortar. The equipment and its operation shall be subject at all times to the approval of the Engineer.

- C. The mortar shall be proportioned on the basis of integral sacks of cement, and the amount of sand shall be determined by direct weighing. The amount of water used shall be that required to produce mortar of suitable consistency, quality, and uniformity with the minimum rebound.
- D. Fine aggregates shall conform to the requirements of ASTM C-33. Aggregate for air blown mortar may consist of not more than 30% pea gravel with a maximum nominal size less than 3/8 inches.

## 2.06 JOINT SEALANT

- A. The adhesive sealant will be a single component high performance low modulus elastomeric sealant acceptable for a water immersion application, Sika/Sikaflex-1a or approved equal. The color of the sealant will be white or as approved by the Engineer.
- B. The joint sealant primer will be non-toxic and non-staining, Sika/Sikaflex Primer 429/202, or as recommended by the joint sealants manufacturer.
- C. The sealant backer rod will be compressible polyethylene foam rod or other flexible, permanent, durable non-absorptive material recommended by the joint sealant manufacturer and compatible with the joint sealant.

## 2.07 ESCAPE LADDERS

- A. Ladders shall be fabricated per the Drawings, and shall be galvanized before placing in the concrete lining.

## **PART 3 EXECUTION**

### 3.01 EXCAVATION AND PREPARING EARTH FOUNDATION FOR CANAL LINING

- A. Solano Irrigation District will complete the initial removal of the irrigation water from the canal and siphons. Additional dewatering due to canal and groundwater seepage, surface runoff or rainfall shall be at the responsibility of the Contractor, refer to General Requirements 01100 Section 1.05.
- B. GENERAL
  - 1. Excavation may be made by equipment optional to the Contractor insofar as the neat uniform excavation lines shown on the Drawings are maintained. Excavation shall be performed to the lines and grades established by the Engineer. The canal embankment grading and trimming operation shall be formed by motor grader equipment and performed simultaneously with the canal excavation.

## C. CANAL EXCAVATION

1. Canal excavation may be made by dragline, carryall, ditcher or other equipment optional to the Contractor insofar as the neat uniform excavation lines shown on the Drawings are maintained, and insofar as the embankment construction shall conform to the requirements of subsections 3.07 and 3.08.
2. The canals shall be excavated to the full depth and widths shown on the drawings and finished uniformly to the lines and grades established by the Engineer except where, during the progress of the work, the Engineer directs the Contractor to change the side slopes. Any increase in excavation quantities as a result of changing the side slopes of the canals beyond the slopes shown on the drawings will be performed at the unit price per cubic yard named in the schedule for canal excavation.
3. The bottom and side slopes or excavation upon or against which concrete is to be placed shall be finished accurately to the dimensions shown on the drawings or prescribed by the Engineer. If, at any point, material is excavated beyond the neat lines required to receive the concrete lining or the natural foundation is disturbed or loosened during the excavation process, the foundation for the structure shall be brought back to grade and consolidated in a manner satisfactory to the Engineer.
4. Runways for excavation equipment shall not be cut into canal slopes below the design water level. Runways above design water level into the finished canal prism shall be spaced not less than five hundred feet (500') apart. Uncontrolled travel up and down interior slopes of finished canal prisms by construction equipment will not be permitted.

## D. BORROW EXCAVATION

1. Excavation shall be performed to the lines and grades established by the Engineer. Upon completion of borrow operations, borrow pits shall be left in a reasonably smooth, even and free draining condition. The Engineer will so direct the Contractor when borrow excavation is to be utilized. Where rock surfaced roadways exist through the borrow area, the existing rock surfacing shall be salvaged for reuse as directed by the Engineer.

## 3.07 CANAL EMBANKMENTS

- A. Canal embankments shall be constructed as herein specified to the cross section shown on the Drawings or as directed by the Engineer. The ground surface at the top of bank of all canals shall be graded to slope away from the canal as shown on the Drawings. The Contractor shall slope the ground surface simultaneously with canal finish so as to provide continuous protection against erosion of the interior canal prism.

- B. The entire surface of the foundation for canal embankments shall be scarified or plowed to a depth of not less than six inches (6"). In order to secure an adequate foundation and bond for canal embankments, the foundation material shall have the optimum practicable moisture content. If necessary to obtain the required moisture content, the Contractor shall add water.
- C. Wheel-Rolled Canal Embankments: The construction procedure used for wheel-rolled canal embankments will be by one of the following methods:
1. When the embankment is made with wheeled scrapers or other hauling equipment the fill shall be leveled off in uniform lifts eight inches (8") thick and the equipment shall be so routed as to provide for maximum coverage of the surface area by the wheels. Special care shall be exercised to obtain proper moisture control and compaction at the interior trim line of the canal prism.
  2. When a Briscoe Pitcher or dragline is used, a wheel-compacted pad shall be constructed to the required elevations and sections. The canal shall then be constructed to lines and grades shown on the drawings.
  3. Travel of the construction equipment shall be so routed over the layers of earth material to distribute the compacting effect to the best advantage. In the event adequate compaction is not obtained in the placing of the material by passage of the hauling equipment over the material, the Engineer may require additional compaction as provided for in subsection 3.08.
- D. Compacted Canal Embankments
1. Where shown on the drawings or directed by the Engineer, the Contractor shall compact canal embankments over and above the compaction obtained by the methods set forth in subsection 3.08.C.
  2. Where compacting of cohesive earth materials is required, the materials shall be deposited in horizontal layers of not more than six inches (6") thickness.
  3. When the material has been conditioned as specified in subsection 3.07.E, it shall be compacted by sheepsfoot rollers of sufficient weight for proper compaction, or other equipment approved by the Engineer.
  4. See Section 3.08 for required compaction levels.
- E. Prior to and during compaction, the embankment materials shall have the optimum practicable moisture content required for the purpose of compaction, and the moisture shall be uniform throughout each layer. Insofar as practicable, moistening of the material shall be performed at the site of excavation, but such

moistening shall be supplemented by sprinkling at the site of compaction, if necessary. If the moisture content is less than optimum for compaction, the compaction operations shall not proceed, except with the specific approval of the Engineer, and if the moisture content is greater than optimum for compaction, the compaction operations shall be delayed until such time as the material has dried to the optimum practicable moisture content, and no adjustment in price will be made on account of any operation of the Contractor in drying the materials or on account of delays occasioned thereby.

- F. The grading, trimming, and leveling operation shall be performed by motor grader equipment, operating simultaneously with the placing of embankments. The finer portions of the material shall be deposited in or graded to the section of the canal embankment next to the canal prism.

### 3.08 COMPACTION LEVELS

- A. Refer to subsection 1.05 for required compaction test methods. Compaction testing will be performed by the Engineer.
- B. Embankments: The following compaction standards shall be met in embankments:
  - 1. Compacted embankments, cohesive materials: dry density of not less than ninety percent (90%) of the laboratory standard maximum soil dry density.
  - 2. Compacted embankments, cohesionless materials: dry density of not less than seventy percent (70%) of the relative dry density.
  - 3. Canal embankments, cohesive materials: dry density of not less than ninety percent (90%) of the laboratory standard maximum soil dry density.
  - 4. Canal embankments, cohesionless materials: dry density of not less than seventy percent (70%) of the relative dry density.
  - 5. Structural backfill, cohesive materials: dry density of not less than ninety percent (90%) of the laboratory standard maximum soil dry density.
  - 6. Structural backfill, cohesionless materials: dry density of not less than seventy percent (70%) of the relative dry density.

### FINISH AND TOLERANCE

- A. In canal sections of full cut, the Contractor shall finish side slopes immediately behind each three foot (3') increment of canal depth, more or less, to prevent loss of moisture content in the exposed soil prior to finishing, and to provide adequate control of slope and alignment. In sections of partial or full canal embankment, the Contractor shall so coordinate his finishing operations as to insure the movement of earth in accordance with the mass diagrams. Trimming shall be

performed while the earth is at optimum moisture content in accordance with subsection 3.07.E.

- B. Site surfaces and exterior bank slopes shall be trimmed to lines and grades by a motor grader if practicable.
- C. Excavation finished elevations shall be within 0.1 feet of those staked.  
Embankment finished elevations shall be within 0.05 feet of those staked.

#### CHANNEL IMPROVEMENTS

- A. Trees and brush shall only be cut, trimmed or removed at direction and approval of the Engineer.
- B. The District will designate rights of way to be used by clearing, excavation and lining equipment. Maximum care shall be used to confine equipment to operation only within such rights of way.
- C. The Contractor shall perform any fine grading necessary before the placement of geomembrane lining. If at any point, the foundation material is disturbed or loosened during the process, it shall be consolidated in a manner satisfactory to the Engineer. If at any point material is excavated beyond the neat lines required to receive the concrete, the excess excavation shall be filled with selected material, moistened, if required, and compacted in a manner satisfactory to the Engineer. Immediately prior to placing concrete the foundation will be thoroughly moistened.
- D. The Contractor shall remove any dirt and surface scaling at the joint of the existing concrete structures in order that a good bond of the new lining to the structures can be achieved as shown in the Drawings. The method of removal will be by hand scrubbing, scrapping or sandblasting. All other methods shall be approved by the Engineer.

#### 3.02 GEOMEMBRANE LINING

- A. Deployment:
  - 1. The geomembrane panels shall be set out in accordance with the manufacturer's recommendations and shall comply with the following guidelines.
    - a. Sandbags or approved equal shall be used for ballast and to prevent wind uplift.
    - b. Personnel walking on the geomembrane shall not engage in activities or wear shoes that could damage the geomembrane. Smoking will not be permitted on the geomembrane.

- c. Heavy vehicular or equipment will not be permitted to travel directly on the geomembrane unless protective measures are followed as required by the geomembrane manufacturer.
- d. Sufficient material (slack) shall be provided to allow for thermal expansion and contraction of the geomembrane during installation.

B. Field Seaming:

1. To the maximum extent possible, the seams shall be perpendicular to the canal unless otherwise approved by the Engineer.
2. Slope panels shall extend a minimum of five (5) feet beyond the grade break into the flat area.
3. Alignment of the seam overlaps shall be consistent with the requirements of the welding equipment being used. A minimum of six (6) inches of overlap is required.
4. Welding equipment and accessories shall meet the manufacturer's recommendations and requirements.
5. Trial welds shall be performed on geomembrane samples to verify the welding equipment is operating properly.
6. No welding equipment or welder shall be allowed to perform production welds until the equipment and welders have successfully completed acceptable trial welds.
7. Seaming shall not proceed when ambient air temperature or adverse weather conditions jeopardize the integrity of the liner installation.

C. Repair:

1. Damaged geomembrane shall be removed and replaced with acceptable geomembrane material if damage cannot be satisfactorily repaired as directed by the Engineer.
2. All patches or caps shall extend a minimum of six (6) inches for extrusion welds and four (4) inches for wedge welds beyond the edge of the defect and around all edges of the patch material.
3. Damaged geomembrane shall be repaired using one of the following repair methods as agreed upon by the Contractor and the Engineer:
  - a. Abrading and Re-welding – used to repair a short section of seam.

- b. Spot Welding – used to repair pinholes or other minor, localized flaws or where the geomembrane thickness has been reduced.
- c. Capping – used to repair long lengths of failed seams.
- d. Flap Welding – used to extrusion weld the flap (excess outer portion) of a fusion weld in lieu of a full cap.
- e. Remove the unacceptable seam and replace with new material.

### 3.03 CONCRETE PROPORTIONING

- A. The Contractor shall furnish concrete which will develop a minimum compressive strength of three thousand pounds per square inch (3,000 psi), and shall conform to the basic requirements set forth in these Specifications.
- B. The new water-cement ratio of the concrete (exclusive of water within or absorbed by the aggregates) shall not exceed 0.60 by weight. A minimum of five and one-half (5 ½) sacks of cement to each cubic yard of concrete shall be used.
- C. The slump shall not exceed three and one-half inches (3 ½”). The Engineer reserves the right to alter the required slump whenever, in his judgment, the quality of the work will improve. Slump test, air entrainment test, and test cylinders will be made by the Engineer and such tests shall conform to the latest ASTM procedures.

### 3.04 CONCRETE MIXING

- A. Mixing may be performed at the site of the work or by transit-mix methods. Transit-mixed concrete shall conform to the Standard Specifications for ready-mixed concrete, ASTM Designation C-94.
- B. The total volume of materials mixed per batch shall not exceed the rated capacity of the mixer as determined by the standard requirements of the Associated General Contractors of America.
- C. If a batch mixer is used, the concrete ingredients shall be mixed for not less than one and one-half (1 ½) minutes after all the ingredients, except for the full amount of water, are in the mixer. The mixing shall be increased if the charging and mixing operations fail to produce a concrete in which the ingredients are consistent and uniform throughout.
- D. Water shall be added prior to, during, and following the mixer-charging operation. Excessive overmixing, requiring additional water to preserve the concrete consistency, shall not be permitted. Any mixer that at any time produces unsatisfactory results shall be repaired or replaced.

### 3.05 CONCRETE HANDLING AND PLACING

- A. In preparation for the placing of concrete, all water, construction debris and extraneous matter shall be removed from the canal section. The concrete shall be placed as nearly as possible to its final position by means that avoid segregation of the materials and displacement of the reinforcement.
- B. Precautions and provisions shall be made to avoid plastic shrinkage cracking. When site and/or environmental conditions exist that have a high possibility for plastic shrinkage cracking, the Contractor shall follow these additional requirements:
  - 1. Concrete shall not be placed in conditions where wind speed is or is anticipated to exceed 15 mph or if the combination of environmental and site conditions promote plastic shrinkage cracking.
    - a. At the discretion of the Engineer, concrete placement may be halted or postpone based on the current or forecasted weather conditions.
    - b. Delays in the concrete placement shall not relieve the Contractor from completing the project by the specified completion date stated in the Contract Documents.
  - 2. A written proposal shall be submitted to the District Engineer for approval. The proposal will include the method of concrete placement, alternative mix designs, list of materials, additional finishers and laborers and equipment necessary to minimize the cracking.
    - a. Curing compound shall be applied to the surface immediately following the finishing operation and the entire surface covered with polyethylene sheeting.
    - b. Written approval does not relieve the Contractor of his or her responsibility nor accountability if plastic shrinkage cracking occurs.
  - 3. No additional compensation will be made to the Contractor

### 3.06 PLACING PNEUMATICALLY-APPLIED CONCRETE LINING

- A. All canal gates, pumps and appurtenances shall be properly covered and protected with viscine prior to the placement of the concrete lining.
- B. All absorptive surfaces against which pneumatically applied mortar is to be placed shall be moistened thoroughly. Free water will not be permitted on the surface

during the application. Ground wires shall be installed in the canal prism to outline the finished surface of the lining as shown on the plans or as directed by the Engineer.

- C. The mortar shall be applied from a nozzle held approximately four feet (4') from the surface, and in a stream as nearly perpendicular to the surface being covered as practicable.
- D. The pressure in the placing machine shall be maintained at not less than forty-five pounds per square inch (45 psi) for hose lengths up to one hundred feet (100') and shall be increased five pounds per square inch (5 psi) for each additional fifty feet (50') of hose. Water pressure shall be maintained at least fifteen pounds per square inch (15 psi) greater than the pressure in the placing machine.
- E. Sand pockets shall be removed and replaced with pneumatically applied mortar as herein specified. Rebound shall not be incorporated in the work in any manner.
- F. Construction joints shall be sloped to a thin edge and the edge shall be thoroughly cleaned and wetted before the adjacent section of mortar is placed.

### 3.07 PLACING SLIP-FORMED CONCRETE LINING

- A. The concrete lining shall be placed on a geomembrane liner which shall be placed against undisturbed earth, compacted embankment or existing concrete liner. The type of construction will be optional to the Contractor provided that neat, accurate, and durable concrete lining, as provided for in these specifications, is the finished product.

### 3.08 FINISHING CONCRETE LININGS

- A. The finished surface of canal lining shall be equivalent in evenness, smoothness, and freedom from rock pockets and surface voids to that obtainable by the effective use of a long-handled steel trowel. Shallow surface pitting and trowel marks are not objectionable.
- B. Deviations from true line and grade shall not exceed five-hundredths (0.05') of a foot over a length of twenty feet (20'). There shall be no abrupt changes in section, line or grade. Exceptions to this shall only occur at the beginning and termination points as shown in the Drawings.
  - 1. At no time shall the concrete liner be less than 2 ½" thick or as shown in the Drawings.
- C. Transverse grooves, three-quarter inch (¾") deep and approximate one-half inch (½") wide, shall be made in the concrete lining. The first groove shall be made ten feet (10') from the end of the lined section and at ten-foot intervals throughout the full length of the lined section.

### 3.09 CURING CONCRETE LININGS

- A. Concrete lining shall be cured by a white pigmented membrane curing compound. Membrane curing shall be by application of a sealing compound conforming to ASTM C-309. Sealing compound shall be applied to the concrete surfaces by spraying in one coat to provide a continuous, uniform membrane over all areas.
- B. The temperature of concrete as mixed and placed shall not be less than 55°F, nor greater than 90°F. If, during day or night, the ambient temperature falls below or is predicted to fall below 40°F, concrete shall be protected from freezing during placement and curing by means of heating of materials and other approved methods, as directed by the Engineer.
- C. The concrete mix for cold weather placement shall be maintained at a minimum temperature of 55°F during placement and this minimum temperature shall be maintained for the first 72 hours of curing.
- D. The maximum temperature of concrete as placed shall be less than 90°F. When the temperature of concrete as placed may be 90°F or higher, as may be reasonably predicted from current temperatures of materials and the likelihood of rises in weather temperatures, the Contractor shall employ effective means, such as precooling aggregates and mixing water, use of ice as part of the mixing water, shading aggregates, or placing at night, as necessary, to maintain the temperature of concrete, as placed, below 90°F.

### 3.10 CONCRETE PANEL INSPECTION AND REPAIR

- A. After three days of curing, the concrete panels will be inspected by the District's Inspector. All visible cracks will be marked with a water-based spray paint and be given a rating of 0, 1, 2 or 3 based on its severity.
  - 1. Rating 0 (0" to less than 1/8" in width): Crack will be monitored for thirty (30) days after the placement of the concrete. Crack will not be repaired unless it expands to a rating of 1.
  - 2. Rating 1 (1/8" to less than 5/16" in width): Crack will be primed and sealed with an adhesive joint sealant. Crack will be properly prepared and primed for water immersion as directed by the joint sealant's manufacturer.
  - 3. Rating 2 (5/16" to less than 1/2" in width): Crack will be repaired with properly sized and installed sealant backer rod, primer and adhesive joint sealant. Crack will be properly prepared and primed for water immersion as directed by the joint sealant's manufacturer.
  - 4. Rating 3 (1/2" and greater in width): Concrete panel will be removed and replaced or repaired as directed by the Engineer.

- B. The crack shall be clean, dry, frost-free and free of oil and grease. Curing compound residue and other foreign matter must be thoroughly removed prior to the application of the joint sealant primer.
- C. The air temperature at the time of application will be between 40° and 100°F or as recommended by the sealant and primer manufacturer.
- D. All cracks shall be repaired and allowed to cure for one week prior to total water immersion.

### 3.11 ESCAPE LADDERS

- A. Ladders shall be installed in all lined canals at the locations and at spacing shown in the Drawings.
- B. Ladders shall be embedded in the freshly placed lining before it sets.

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## SECTION 02513

### **GRAVITY IRRIGATION PIPELINES – RUBBER GASKETED REINFORCED CONCRETE PIPE (RGRCP)**

#### **PART 1 GENERAL**

##### 1.01 SECTION INCLUDES

- A. Irrigation pipeline, as herein specified, consists of installing pipe by open-trench methods at the locations indicated in the Drawings. The Contractor shall provide all labor, material and equipment necessary to install the pipe, specials and appurtenant apparatus required to complete the pipeline installation in an operating, watertight condition. The Contractor shall also furnish all supports, bracing and other materials and all work required for hauling, unloading, trenching, protecting, dewatering, placing, backfilling, and cleanup of the irrigation pipeline installation.
- B. The Contractor is hereby notified that **the District’s agricultural irrigation distribution pipelines are pressure pipelines**, unlike gravity storm drain pipelines, and are therefore constructed to tighter standards than such storm drain pipelines.
- C. All materials and installation of the pipe shall be in accordance with the standards and specifications of the Solano Irrigation District, latest revisions.

##### 1.02 RELATED SECTIONS

- A. Section 01100 – General Requirements
- B. Section 02300 - Earthwork

##### 1.03 SCHEDULING

- A. **Interruption of agricultural irrigation water service to lands downstream of the subject project will not be permitted.** Refer to Section 01100.1.04.A. Removal of existing pipelines and installation and reconnection of new pipelines shall be scheduled and coordinated with the Engineering and Agricultural Operations Departments.

##### 1.04 SUBMITTALS

- A. Submit three certified copies of tests on the rubber compound used in all rubber gasket joints.
- B. Submit three copies of line lists, shop and fabrication drawings for reinforced concrete pipe and special fittings of steel and concrete.

- C. County Encroachment permit and Traffic Control Plan, required for all road crossings and work within County right-of-ways.

#### 1.05 GUARANTY AND MAINTENANCE

- A. The Contractor guarantees the pipelines against defective workmanship, materials, and against leakage for a period of one (1) year after the pipeline is accepted by the District. The Contractor agrees to repair all leaks and to maintain the pipeline in a satisfactory operating condition during the one-year period. Upon notice to the Contractor by the District of needed repairs, the Contractor shall undertake such repairs, including necessary dewatering, within forty-eight (48) hours. Neither the guarantee nor the maintenance requirements shall apply to damage to the pipelines caused by an Act of God, negligence in the operation of the system, or acts of third parties.
  - 1. If the Contractor cannot comply with the forty-eight (48) hour requirement, the District will complete the repairs, which may include hiring another contractor, and bill the contractor for the costs.

#### 1.06 MEASUREMENT AND PAYMENT

- A. Air Release Valve Assemblies will be paid for at the applicable unit price each as bid in the Bid Schedule.
- B. Capped Valve Assemblies will be paid for as part of the Access Manhole assembly to which they are attached.
- C. Air vent risers of PVC, concrete and steel shall be paid for at the applicable unit price per foot bid in the Bid Schedule.
- D. Payment for pipelines shall be at the unit price per foot bid therefor in the Bid Schedule. Payment for main pipelines shall include pipe, fittings, specials, manholes, bends, concrete pipe collars, connections, metallic warning tape, tracer wire, potholing, trenching, over-excavating, placing, dewatering, shoring, bracing, bedding, thrust blocks, backfill, compaction, testing, permits, inspection, cleanup, guaranty, maintenance and all other labor and materials required to construct the pipelines.
- E. All labor and materials for which there is no item in the Bid Schedule shall be included in the unit price bid therefor for the applicable size pipe to which they are appurtenant.

## PART 2 MATERIALS

### 2.01 REINFORCED CONCRETE LOW-HEAD PRESSURE PIPE

- A. Pipe: Reinforced concrete pipe with rubber gasket joints shall be manufactured in conformance with ASTM C-361, shall be manufactured by the centrifugal spin method, and shall be reinforced to meet the loading requirements of ASTM C-76, Class III or as shown on the Drawings. The pipe shall be manufactured to the pressure class requirements of ASTM C-361 necessary to pass the hydrostatic field testing requirements stated herein. Cement shall be Portland Cement Type II. The bell and spigot joint shall be self-centering, shall have an “o-ring” rubber gasket, and shall meet the requirements of AWWA C-302. The gasket material shall conform to ASTM C-443. The pipe shall be provided in lengths of not less than twelve feet (12') except for specials and makeup joints.
- B. Steel Specials and Fittings:
1. Specials and fittings shall meet the requirements of Section 4 of AWWA C200, or shall be of the same material and strength specifications as the pipeline of which they are a part, provided the steel reinforcement is equal to or greater in area. All pipes shall be electrically welded pipe fabricated from steel plate in conformance with ASTM A-283, Grade C or D, or ASTM A-570, Grade 30 or 33. The pipe shall be fabricated to the configuration shown on the Drawings. The wall thickness of the various components of piping shall be standard wall unless otherwise shown in the Drawings. Except where otherwise noted, the dimensions of specials and fittings shall be in accordance with AWWA C-208. Steel outlets for manholes, turnouts and blowoffs shall be as shown in the Standard Details. Reinforcement of openings shall conform to Section VIII of the ASME Boiler and Pressure Vessel Code. The Contractor shall furnish and install flanges, mechanical couplings required to join the irrigation pipeline to manifolds.
  2. Flanges shall conform to AWWA C-207. All flanges shall be class D unless otherwise noted on the Drawings. All bolts and nuts shall be galvanized as specified in ASTM Designation A-153. Flange gaskets shall be as specified in AWWA Standard C-207. All flanges shall be marked in accordance with Section 1.4 of AWWA C-207. The bolting shall be drawn up evenly around the periphery of the flange to ensure even pressures on the gasket.
  3. Field welding of pipe joints and attachments shall conform to AWWA C-206.
- C. Fabricated RGRCP Bends: Factory-fabricated concrete pipe specials and fittings shall meet the requirements of Section 4 of AWWA C200, or shall be of the same material and strength specifications as the adjoining pipeline, provided the steel reinforcement is equal or greater in area. The Contractor will be permitted to use field-fabricated bends which will assure equivalent performance equivalent to factory-fabricated pipe. Field-fabricated bends can only be used on pipelines with a design pressure of 5 psi or less (11.55' of head or less) as shown in the Standard

Details. If the Contractor elects to field fabricate bends other than as shown therein, complete fabrication dimensions and material details of the proposed bends shall be submitted for District review. The District reserves the right to require, at no additional cost to the District, such modifications or alterations as deemed necessary by the Engineer.

#### 2.04 STEEL PIPE

- A. Steel pipe shall be electrically welded. Wall thickness shall be “Standard Wall” for that size of pipe unless otherwise noted on the Drawings or Standard Details.
- B. The interior and exterior surfaces of all steel pipe shall be properly cleaned, prepared and coated with:

Field Application - Devoe “Bar-Rust 233H”, buff color (#233H1642) or approved equal, per the manufacturer’s recommendations.

Factory Application – shall be either coal tar epoxy per AWWA C210 or Fusion bonded epoxy systems per AWWA C213, or approved equal. The minimum thickness shall be 20 mils.

#### 2.05 SECTIONALIZING VALVES

- A. In-line valves shall be butterfly valves shall conform to the applicable provisions of AWWA C504, and be flanged (short body), and not of the wafer type. Valves shall be Class 150 pressure rating, show no leakage under 200 psi of pressure, and shall be as manufactured by Pratt or approved equal. Valves shall include all flanges, gaskets, bolts and all else required to install the valve in a watertight condition. Valves shall be furnished with fabricated flange by bell adapters.

#### 2.06 ACCESS MANHOLES

- A. Access manhole installations shall include all concrete and steel piping, fittings, flanges, handles, bolts, outlets, nipples, valves, caps, concrete pipe risers, manhole frame, cover and grade rings, coating, concrete, backfill, embankment, compaction, grading and all other fittings and materials required to complete the access manhole installation in a watertight and operating condition as indicated on the Drawings.

#### 2.07 AIR RELEASE VALVES AND VENTS

- A. Air Release Valve: All air release valves for ARV installations shall have the same pressure rating as the pipeline at the point of installation. Above-ground piping, below-ground piping and housing shall be as shown in the Standard Details. Air release valves shall be Waterman Model CR-101, or approved equal.

- B. Air Vent: Air vents shall be required for open vented pipelines with less than ten feet (10') of head. The vent will be PVC pipe installed on modified manhole lid per the Standard Details, latest revision.

## 2.08 CONCRETE FOR THRUST BLOCKS

- A. Concrete used for thrust blocks shall have a 28-day relative compressive strength of 3,000 psi, minimum, and a maximum 6" slump.

## PART 3 EXECUTION

### 3.01 TRENCHING AND BACKFILLING PIPELINES

- A. Refer to Section 02300 – Earthwork, subsection 3.12 – Trenching for Pipe and subsection 3.13 – Backfill of Pipe.

### 3.02 HANDLING OF PIPE

- A. During handling, loading, transportation and unloading, every precaution shall be taken to prevent damage to the pipe. The manufacturer's recommendations for the handling of the pipe shall be followed in all details. Pipe shall be handled gently and not dropped on the ground or into the trench. No pipe shall be dropped or allowed to roll down skids.
- B. During the transportation, storing and stringing, each pipe shall rest upon suitable pads, strips or blocks as recommended by the manufacturer, and shall be securely wedged in place. Each section of pipe shall be delivered on site as near as practicable to the place where it is to be placed and shall be faced in the proper direction for laying.
- C. Where necessary to move the pipe longitudinally along the trench, it shall be done in such a manner as to prevent damage to the pipe. The Contractor will load and haul the pipe to the site of the work not more than 12 calendar days in advance of laying the pipe. This will require the coordination from the Engineer and the Agricultural Operations Department.
- D. Any damage to the pipe shall be carefully repaired by the Contractor in accordance with the pipe manufacturer's recommendations and to the satisfaction of the District prior to placement of the pipe in the trench. Repairs cannot be made in the trench. All repairs shall be fully cured and inspected prior to their placement and/or backfilling. Damaged pipe that cannot be repaired shall be marked with paint "DO NOT USE" and be removed from the site.

### 3.03 PIPELAYING

- A. The pipe shall be placed firmly in the center of the trench and true to the established line and grade. The pipe shall be fully supported longitudinally and

laterally on the specified bedding material. On slopes greater than ten percent (10%), the pipe bells shall be pointed upgrade and the laying shall proceed upgrade.

- B. Except as required for backfilling, the Contractor shall prohibit walking or working upon the pipe until backfilling of the trench has been completed. The Contractor shall provide temporary bridging over pipe trenches where it is necessary to provide crossings for workmen and equipment or access roads. All provisions the Contractor makes with regard to trench safety shall follow the current guidelines set by Cal-OSHA.
- C. Flotation: The Contractor shall take all necessary precautions to prevent the pipe from floating due to water entering the trench from any source, shall assume full responsibility for any damage, and shall, at Contractor's own expense, restore and replace the pipe to its specified condition and grade if it is displaced due to flotation.

### 3.04 ASSEMBLY OF REINFORCED CONCRETE PIPE

- A. General: The pipe joints shall be assembled according to the manufacturer's recommendations, these Specifications and as directed by the Engineer, but regardless of the method used the joints shall be watertight. Fabricated bends for reinforced concrete pipe shall be installed where specifically indicated on the drawings.
- B. Gasket Installation: All gaskets shall be stored in a cool, well-ventilated place and shall not be exposed to the direct rays of the sun until immediately before joint assembly. The gasket shall be stretched and placed on the pipe in a manner so that the rubber is distributed uniformly around the entire pipe circumference. Care shall be taken in fitting the pipe together to avoid twisting or otherwise displacing or damaging the gasket. The joints shall be lubricated and assembled in accordance with the recommendations of the pipe manufacturer. After the joint has been assembled, the position of the rubber gasket shall be verified by passing a feeler gauge around the complete circumference of the pipe. If the gasket is fish-mouthed or otherwise displaced, the joint shall be disassembled, a new gasket installed, the pipe relaid and the position of the gasket rechecked.
- C. Pipe Assembly: Rubber gasket pipe shall be installed with maximum joint gaps not exceeding 75% of the manufacturer's recommended gap. The gap shall be internally verified for each joint. Long radius curves may be constructed by pulling the pipe at the joints. The maximum deflection angle at a pulled joint shall not exceed one degree (1°) or as recommended by the manufacturer, both cases shall meet the above requirement. Beveled joints with a maximum deflection of up to five degrees (5°) will be permitted provided all components of the joint meet the pipe manufacturer's recommendations. If it is necessary that a pipe is moved or that the alignment be adjusted after it has been installed, it shall be moved, rejoined and gap checked as was accomplished in the original installation.

- D. Sectionalizing Valves: Valves shall be installed utilizing steel flange by bell adapters. The adapters will have a factory applied mortar or epoxy lining and coating. If field touchups are required, they shall be completed per the manufacturer's recommendations and be fully cured before installation. The valves shall be installed with traffic box covers per the Standard Details.
- E. Access Manholes: The access manhole installation will be defined by the Engineer as specified in the Drawings. As called for in the Drawings, an ARV Assembly, a Capped Valve Assembly, or a Vent Pipe Assembly shall be installed. Refer to the current Standard Details.

### 3.05 THRUST BLOCKS

- A. Thrust blocks for reinforced concrete pipe shall be provided at all joints in fabricated bends where the deflection angle at the joint is equal to or greater than ten degrees (10°).
- B. Thrust blocks shall be unreinforced concrete placed against undisturbed earth as shown in the Standard Details. The exterior of the pipe shall be thoroughly moistened immediately prior to pouring the concrete. The thrust blocks shall be centered about the center line of the joint and the pipe, shall have a minimum dimension parallel to the pipe centerline of one foot (1'), shall be equal in width to the pipe trench, and extend to six inches (6") below the bottom and above the top of the pipe.
- C. Thrust blocks for fabricated bends and tees shall form an integral part of the joint.
- D. Concrete thrust blocks shall be cured one (1) day before the pipeline may be filled with water and three (3) days before the pipeline may be pressurized.

### 3.07 PIPELINE CONNECTION BLOCKS

- A. Where necessary to connect to existing dissimilar types of pipe or join to different installation runs of pipe with a separation gap of less than forty-eight inches (48"), the Contractor shall install pipeline connection blocks as shown in the Standard Details.

### 3.08 HYDROSTATIC TESTING

- A. General: in addition to hydrostatic shop or plant tests for pipe, a hydrostatic field test shall be required for the pipeline and all appurtenances. The Contractor shall provide all labor, equipment, materials, bulkheads and recently-calibrated measuring apparatus required to make the test. The District shall not be responsible for any damage, including damage to the pipeline, due to testing.
- B. Prior to Testing: The Contractor shall submit his proposed testing procedure for approval, in writing, to the Engineer prior to starting any testing. The line may be

tested in one length, between valves, or between Contractor-furnished and installed bulkheads, as approved. By necessity, installation of all valves, air release valves, air vents, thrust blocks and backfill shall be completed so that testing may be undertaken. The Contractor may fill the pipeline to check for leaks before backfilling the trench, but must repair any resulting damage or displacement to the pipeline. Said pipeline filling before trench backfilling will not satisfy the hydrostatic testing requirement. The test shall be made as soon as practical after completion of the pipeline, but in no event sooner than the concrete thrust blocks have reached the required design strength that will be subjected to hydrostatic forces during a test. The pipe shall be filled, and remain filled, for at least twenty four (24) hours prior to the start of field testing.

C. Test Requirements

1. The pressure for testing shall be equal to 120 percent (120%) of the design head. The Engineer shall establish the design head. Compensation for the difference in static head shall be made if the test gauge is placed at a location other than the low point of a test reach.
2. The pipeline must remain under the required pressure for twenty four (24) hours.
3. Under these test conditions, the maximum leakage shall not exceed the following amounts:
  - a. Reinforced concrete pipe: eighty (80) gallons per day, per inch of pipeline diameter, per mile of pipe.
  - b. Steel pipe with welded joints: no leakage
  - c. Steel Pipe and cylinder pipe, with rubber gasket joints – thirty (30) gallons per day, per inch of pipeline diameter, per mile of pipe.
4. Makeup water to replace leakage will be accurately metered as it is added to the pipeline.
5. The Contractor shall continue testing and repair until the actual leakage is reduced to or below the allowable leakage for twenty-four (24) hours. Regardless of the measured leakage from the pipe, the Contractor shall repair all visible leaks. Leaks shall be repaired by and at the expense of the Contractor. If leakage persists after the repair, the joint or joints of pipe in question shall be removed and replaced with new pipe and retested.

/// END OF SECTION

## SECTION 02514

### GRAVITY IRRIGATION PIPELINES - POLYVINYLE CHLORIDE (PVC)

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Irrigation pipeline, as herein specified, consists of installing pipe by open-trench methods at the locations indicated in the Drawings. The Contractor shall provide all labor, material and equipment necessary to install the pipe, specials and appurtenant apparatus required to complete the pipeline installation in an operating, watertight condition. The Contractor shall also furnish all supports, bracing and other materials and all work required for hauling, unloading, trenching, protecting, dewatering, placing, backfilling, and cleanup of the irrigation pipeline installation.
- B. The Contractor is hereby notified that **the District's agricultural irrigation distribution pipelines are pressure pipelines**, unlike gravity storm drain pipelines, and are therefore constructed to tighter standards than such storm drain pipelines.
- C. All materials and installation of the system shall be in accordance with the standards and specifications of the Solano Irrigation District, latest revisions.

##### 1.02 RELATED SECTIONS

- A. Section 01100 – General Requirements
- B. Section 02300 – Earthwork
- C. Section 02519 – Conductive Trace Wire for Nonmetallic Pipe Installation
- D. Section 02740 – Asphaltic Concrete Paving

##### 1.03 SCHEDULING

- A. **Interruption of agricultural irrigation water service to lands downstream of the subject project will not be permitted.** Refer to Section 01100.1.04.A. Removal of existing pipelines and installation and reconnection of new pipelines shall be scheduled and coordinated with the Engineering and Agricultural Operations Departments of Solano Irrigation District.

#### 1.04 SUBMITTALS

The Contractor shall submit the following:

- A. Certificates of compliance with specified standards for PVC pipe and elastomeric gaskets.
- B. Submit three copies of line lists, shop and fabrication drawings for PVC pipe and special fittings of steel and concrete.
- C. County Encroachment permit and Traffic Control Plan, required for all road crossings and work within County right-of-ways.

#### 1.05 WARRANTY

- A. The Contractor guarantees the pipelines against defective workmanship, materials, and against leakage for a period of one (1) year after the pipeline is accepted by the District. The Contractor agrees to repair all leaks and to maintain the pipeline in a satisfactory operating condition during the one-year period. Upon notice to the Contractor by the District of needed repairs, the Contractor shall undertake such repairs, including necessary dewatering, within forty-eight (48) hours. Neither the guarantee nor the maintenance requirements shall apply to damage to the pipelines caused by an Act of God, negligence in the operation of the system, or acts of third parties.
  - 1. If the Contractor cannot comply with the forty-eight (48) hour requirement, the District will complete the repairs, which may include hiring another contractor, and bill the contractor for the costs.

#### 1.06 MEASUREMENT AND PAYMENT

- A. Air Release Valve Assemblies will be paid for at the applicable unit price each as bid in the Bid Schedule.
- B. Air vent risers of PVC and steel shall be paid for at the applicable unit price per foot bid in the Bid Schedule.
- C. Payment for pipelines shall be at the unit price per foot bid therefor in the Bid Schedule. Payment for main pipelines shall include pipe, fittings, specials, bends, connections, metallic warning tape, tracer wire, potholing, trenching, over-excavating, placing, dewatering, shoring, bracing, bedding, thrust blocks, backfill, compaction, testing, permits, inspection, cleanup, guaranty, maintenance and all other labor and materials required to construct the pipelines.
- D. All labor and materials for which there is no item in the Bid Schedule shall be included in the unit price bid therefor for the applicable size pipe to which they are appurtenant.

## PART 2 MATERIALS

### 2.01 PVC DISTRIBUTION PIPE

A. PVC distribution pipelines shall be made of material class 12454-B, have rubber gasketed bell-and-spigot joints conforming to ASTM D-3139, and conform to Soil Conservation Service Specification 430-DD and ASTM-D-2241 as modified by SCS 430-DD. Pipe shall be PW Pipe “TwinSeal Gasketed Pipe” or approved equal. Laying lengths shall be 20 feet long. Fittings and couplers shall meet or exceed the same strength requirements as those of the pipe, and match the size of the pipe. Glued joints are unacceptable.

B. Gravity System Pipe Classes and Materials:

- 1” & 2” – HDPE tubing per Specification Section 02515.2.01.D.
- 4”, 6”, 8”, 10” & 12” – RGPVC, IPS, Class 160
- 15”, 18”, 21” and 24” – RGPVC, PIP, Class 125
- 30” and larger – RGPVC, C-905, DR32.5 (125 psi)

C. Lift System Pipe Classes and Materials:

- 1” & 2” – HDPE tubing per Specification Section 02515.2.01.D.
- 4”, 6”, 8”, 10” & 12” – RGPVC, IPS, Class 160 or Class 200 depending on service pressure
- 14” & larger: refer to the Contract Drawings.

### 2.02 FITTINGS FOR PVC DISTRIBUTION PIPE

A. Gravity systems: fittings shall be RGPVC matching the type of pipe used or ductile iron, mechanical joint or flanged with flanged coupling adapters, or approved equal.

B. Lift systems: fittings shall be ductile iron, mechanical joint or flanged with flanged coupling adapters, or approved equal.

### 2.03 STEEL PIPE, SPECIALS AND FITTINGS

A. Steel pipe:

1. Pipe shall be electrically welded. Wall thickness shall be “Standard Wall” for that size of pipe unless otherwise noted on the Drawings or Standard Details.
2. The interior and exterior surfaces of all steel pipe shall be properly cleaned, prepared and coated with:

Field Application - Devoe “Bar-Rust 233H”, buff color (#233H1642) or

approved equal, per the manufacturer's recommendations.

Factory Application – shall be either coal tar epoxy per AWWA C210 or fusion bonded epoxy per AWWA C213, or approved equal. The minimum thickness shall be 20 mils.

B. Steel Specials and Fittings:

1. Specials and fittings shall meet the requirements of Section 4 of AWWA C200, or shall be of the same material and strength specifications as the pipeline of which they are a part, provided the steel reinforcement is equal to or greater in area. All pipes shall be electrically welded pipe fabricated from steel plate in conformance with ASTM A-283, Grade C or D, or ASTM A-570, Grade 30 or 33. The pipe shall be fabricated to the configuration shown on the Drawings. The wall thickness of the various components of piping shall be standard wall unless otherwise shown in the Drawings. Except where otherwise noted, the dimensions of specials and fittings shall be in accordance with AWWA C-208. Steel outlets for turnouts and blowoffs shall be as shown in the Standard Details. Reinforcement of openings shall conform to Section VIII of the ASME Boiler and Pressure Vessel Code. The Contractor shall furnish and install flanges, mechanical couplings required to join the irrigation pipeline to manifolds.
2. Flanges shall conform to AWWA C-207. All flanges shall be class D unless otherwise noted on the Drawings. All bolts and nuts shall be galvanized as specified in ASTM Designation A-153. Flange gaskets shall be as specified in AWWA Standard C-207. All flanges shall be marked in accordance with Section 1.4 of AWWA C-207. The bolting shall be drawn up evenly around the periphery of the flange to ensure even pressures on the gasket.
3. Field welding of pipe joints and attachments shall conform to AWWA C-206.
4. The interior and exterior surfaces of all steel specials and fittings shall be cleaned and coated with:

Field Application - Devco "Bar-Rust 233H", buff color (#233H1642) or approved equal, per the manufacturer's recommendations.

Factory Application – coal tar epoxy per AWWA C210 or fusion bonded epoxy per AWWA C213.

- a. The use of fusion bonded epoxy fittings requires the addition of two (2) washers for each bolt and nut pair. The washers are to be placed against the epoxy coating in order to distribute the bolt and nut force thereby minimizing epoxy cracking. If cracking does

occur, the special or fitting shall be removed, properly prepared and repaired with Scotchkote 312, or as recommended by the powder epoxy manufacturer.

#### 2.04 SECTIONALIZING VALVES

- A. In-line valves shall be butterfly valves shall conform to the applicable provisions of AWWA C504, and be flanged (short body), and not of the wafer type. Valves shall be Class 150 pressure rating, show no leakage under 200 psi of pressure, and shall be as manufactured by Pratt or approved equal. Valves shall include all flanges, gaskets, bolts and all else required to install the valve in a watertight condition. Valves shall be furnished with flange coupling adapters.

#### 2.05 AIR RELEASE VALVES AND VENTS

- A. Air Release & Vacuum Valves (ARV): All air release and vacuum valves for ARV installations shall have the same pressure rating as the pipeline at the point of installation. Above-ground and below-ground piping shall be as shown in the Standard Details. Air release and vacuum valves shall be Bermad Model 02-ARC-P or Waterman CR101 per the Standard Details.
- B. Open Air Vents: Air vents shall be required for open pipelines with less than ten feet (10') of head. The vent will be PVC pipe installed in a rubber gasketed PVC tee. Solvent welded connections are unacceptable.
- C. ARVs and vents located in open fields or livestock pastures require additional protective measures as shown in the Standard Details.

#### 2.06 CONCRETE FOR THRUST BLOCKS

- A. Concrete used for thrust blocks shall have a 28-day relative compressive strength of 3,000 psi, minimum, and a maximum 6" slump.

### **PART 3 EXECUTION**

#### A. WORKMANSHIP STANDARDS

- A. The size and configuration of the various components of the water system shall be as indicated herein, in the Standard Details, and in the approved Improvement Plans, if any. The work shall be completed in a workmanlike manner to insure an operable and watertight condition.

#### B. TRENCHING AND BACKFILLING PIPELINES

- A. Trench Safety Requirements: the Contractor shall adhere to the Trench Safety Plan outlined in Section 00700.6.10.F.

- B. Refer to Section 02300 – Earthwork, subsection 3.12 – Trenching for Pipe and subsection 3.13 – Backfill of Pipe.

### C. HANDLING OF PIPE

- A. During handling, loading, transportation and unloading, every precaution shall be taken to prevent damage to the pipe. The manufacturer’s recommendations for the handling of the pipe shall be followed in all details. Pipe shall be handled gently and not dropped on the ground or into the trench. No pipe shall be dropped or allowed to roll down skids without proper restraining ropes.
- B. During the transportation, storing and stringing, each pipe shall rest upon suitable pads, strips or blocks as recommended by the manufacturer, and shall be securely wedged or banded in place. Each section of pipe shall be delivered on site as near as practicable to the place where it is to be placed.
- C. Where necessary to move the pipe longitudinally along the trench, it shall be done in such a manner as to prevent damage to the pipe. The Contractor shall load and haul the pipe to the site of the work not more than 12 calendar days in advance of laying the pipe. Any damage to the pipe shall be noted and removed from the project site.
- D. Care shall be taken to prevent permanent distortion and damage when handling plastic pipe during unusually warm or cold weather. Such precautions shall be as recommended by the pipe manufacturer.

### 3.04 PIPE BEDDING

- A. Comply with subsection 3.13 – Bedding and Backfill of Pipe, of Section 02300 - Excavation.
- B. All pipe, specials and fittings shall be bedded in sand. The bedding shall be to the dimensions as shown in the Drawings and Standard Details. The Contractor shall use extreme care in placing the sand under the haunches to assure that all spaces are filled under and about the pipe. The sand bedding shall be compacted to not less than 70% relative density as determined by ASTM D-4253. Jetting of water pipe bedding is not permitted.

### 3.05 PIPELAYING

- A. The pipe shall be placed firmly in the center of the trench and true to line and grade with no visible change in alignment at any joint, unless the alignment is shown to be curved in the Improvement Plans. Joint deflection for curved alignments shall not exceed 80% of the manufacturer’s recommended values. On slopes greater than ten percent (10%) the pipe bells shall be pointed up-grade and laying shall proceed up-grade.

- B. The pipe joints shall be assembled according to the manufacturer's recommendations, these Specifications, and as directed by the Engineer. The use of power equipment such as backhoes or excavators shall be prohibited, unless approved by the Engineer. Regardless of the method used the joints shall be watertight. If it is necessary that a pipe be moved or that the alignment be adjusted after it has been installed, it shall be removed and re-jointed as was accomplished in the original installation.
- C. Except as required for backfilling, the Contractor shall prohibit walking or working upon the pipe until backfilling of the trench has been completed. The Contractor shall provide temporary bridging over pipe trenches where it is necessary to provide crossings for workers and equipment, or access roads.
- D. The Contractor shall take all necessary precautions to prevent the pipe from floating due to water entering the trench from any source, shall assume full responsibility for any damage and shall, at his own expense, restore and replace the pipe to its specified condition and grade if it is displaced due to flotation.

### 3.06 ASSEMBLY OF PVC PIPE

- A. The pipe joints shall be assembled according to the manufacturer's recommendations, these Specifications and as directed by the Engineer, but regardless of the method used the joints shall be watertight.
- B. Elastomeric gaskets for PVC joints, supplied loose, shall be stored in a cool, well-ventilated place, and shall not be exposed to the direct rays of the sun, until immediately before joint assembly.
- C. The joints shall be lubricated and assembled in accordance with the manufacturer's recommendations. There shall be no pulling of joints unless shown in the plans or approved by the Engineer, and shall comply with the manufacturer's recommendations.
- D. Care shall be taken in fitting the pipe together to avoid twisting or otherwise displacing or damaging the gasket. After the joint has been assembled, the position of the gasket shall be verified by passing a feeler gauge around the complete circumference of the joint. If the gasket is "fish-mouthed" or otherwise displaced, the joint shall be disassembled, a new gasket installed, the pipe relaid, and the position of the gasket rechecked.
- E. There shall be no service or appurtenance connections within two (2) feet of a pipe joint, minimum, or as directed by the Engineer.
- F. No rubber-gasket joint shall be encased in concrete.

### 3.07 MAIN FITTINGS AND VALVES

- A. Fittings shall be supported independently of the pipe. Temporary supports under

fittings or under pipe adjoining fittings will not be permitted. Permanent supports under fittings may be redwood blocks or concrete foundations approved by the Engineer.

1. Temporary supports may be used during the curing period of concrete foundations. The supports must be constructed to either become an integral part of the foundation or outside of the required foundation area, as directed and approved by the Engineer.
- B. Preassembling flanged fittings, steel fittings and adjoining pipe, before installation in the trench will be permitted. The bolting shall be drawn up evenly around the periphery of the flange so as to ensure even pressures and required torque on the gasket before lowering into the trench and connecting to the pipeline. The contractor, at no additional expense, shall provide adequate labor force, equipment and harnessing
- required to install the preassembled facilities in a safe and efficient manner or as directed by the District Engineer.
- C. Fittings shall be polyethylene encased per AWWA C105 using PE film. No joint shall be encased in concrete. If necessary the Contractor shall use long or special fittings to comply with this requirement. Fittings shall be clean of pipe bedding material, soil, etc., prior to PE encasement. Ends of the PE film shall be taped closed around the covered materials.
- D. Valves shall be set plumb with operating nuts installed on the side of the valve closest to the curb in streets or as directed by the Engineer in open-fields. Provide a valve box at each valve per the Standard Details.

### 3.08 THRUST BLOCKS

- A. Thrust blocks for PVC irrigation pipelines shall be provided at all joints in fabricated bends where the deflection angle at the joint is equal to or greater than ten degrees ( $10^\circ$ ).
- B. Thrust blocks will be unreinforced concrete placed against undisturbed earth as shown in the Standard Details. When the site has been over excavated, thrust blocks may be cast against backfill approved by the Engineer which is mechanically compacted to ninety-five percent (95%) relative compaction. The compaction shall be verified by an outside agency and the results submitted to the Engineer for approval.
- C. The thrust blocks shall be centered about the center line of the joint and the pipe, shall have a minimum dimension parallel to the pipe centerline of one foot (1'), shall be equal in width to the pipe trench, and extend to six inches (6") below the bottom and above the top of the pipe.

- D. Concrete thrust blocks shall be cured one (1) day before the pipeline may be filled with water and three (3) days before the pipeline may be pressurized.

### 3.09 TRENCH BACKFILL

- A. Warning Tape: Metallic warning tape shall be placed in the same trench, directly over and not more than 12" above all main pipelines, laterals, turnouts and appurtenances installed by open-trench method.
- B. Tracer Wire: If required by the Engineer, comply with Section 02519 – Conductive Trace Wire for Nonmetallic Pipe Installation and the Standard Details.
- C. Backfilling and Compaction: Comply with Section 02300 – Earthwork. Compaction of the backfill material shall be as shown in the Standard Details. The Contractor shall use extreme care when compacting the backfill in the vicinity of the pipe to avoid damaging the pipeline. Jetting of trench backfill is not permitted.

### 3.10 TRENCH RESURFACING

- A. In developed areas and at paved road crossing, trench resurfacing shall comply with Section 02740 – Asphaltic Concrete Paving and the Standard Details.

### 3.11 HYDROSTATIC TESTING

- A. General: in addition to hydrostatic shop or plant tests for pipe, a hydrostatic field test shall be required for the pipeline and all appurtenances. The Contractor shall provide all labor, equipment, materials, bulkheads and recently-calibrated measuring apparatus required to make the test. The District shall not be responsible for any damage, including damage to the pipeline, due to testing.
- B. Prior to Testing: The Contractor shall submit his proposed testing procedure for approval, in writing, to the Engineer prior to starting any testing. The line may be tested in one length, between valves, or between Contractor-furnished and installed bulkheads, as approved. By necessity, installation of all valves, air release valves, air vents, thrust blocks and backfill shall be completed so that testing may be undertaken. The Contractor may fill the pipeline to check for leaks before backfilling the trench, but must repair any resulting damage or displacement to the pipeline. Said pipeline filling before trench backfilling will not satisfy the hydrostatic testing requirement. The test shall be made as soon as practical after completion of the pipeline, but in no event sooner than concrete thrust blocks have reached the required design strength that will be subjected to hydrostatic forces during a test. The pipe shall be filled, and remain filled, for at least twenty four (24) hours prior to the start of field testing.

C. Test Requirements

1. The pressure for testing shall be equal to 120 percent (120%) of the design head. The Engineer shall establish the design head. Compensation for the difference in static head shall be made if the test gauge is placed at a location other than the low point of a test reach.
2. The pipeline must remain under the required pressure for twenty four (24) hours.
3. Under these test conditions, the maximum leakage shall not exceed the following amounts:
  - a. PVC Distribution Pipe: ten (10) gallons per day, per inch of pipeline diameter, per mile of pipe.
  - b. Steel Pipe with Welded Joints: no leakage.
4. Makeup water to replace leakage will be accurately metered as it is added to the pipeline.
5. The Contractor shall continue testing and repair until the actual leakage is reduced to or below the allowable leakage for twenty-four (24) hours. Regardless of the actual leakage from the pipe, the Contractor shall repair all visible leaks. Leaks shall be repaired by and at the expense of the Contractor. If leakage persists after the repair, the joint or joints of pipe in question shall be removed and replaced with new pipe and retested.

/// END OF SECTION

## SECTION 02515

### PRESSURIZED NON-POTABLE WATER SYSTEMS

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Non-potable water system, as herein specified, consists of installing a pressurized pipeline by open-trench methods at the locations indicated in the Improvement Plans. The Contractor shall provide all labor, material, equipment and install the pipe, specials, fittings and all valves and other appurtenant apparatus, and perform all operations required to complete the water system in an operating, watertight condition. The Contractor shall furnish all supports, bracing, other materials and all work required for pipe hauling, unloading, distributing, trenching, protecting, dewatering, placing, backfilling, cleanup and testing of the water system.
- B. The size and configuration of the various components of the water system shall be as indicated herein, in the Standard Details, and in the approved Improvement Plans, if any.
- C. All materials and installation of the system shall be in accordance with the standards and specifications of the Solano Irrigation District, latest revisions.

##### 1.02 RELATED SECTIONS

- A. Section 01100 – General Requirements
- B. Section 02300 – Earthwork
- D. Section 02519 – Conductive Trace Wire for Nonmetallic Pipe Installation
- E. Section 02740 – Asphaltic Concrete Paving

##### 1.03 SCHEDULING

- A. **Interruption of agricultural irrigation water service to lands downstream of the subject project will not be permitted.** Refer to Section 01100.1.04.A. Removal of existing pipelines and installation and reconnection of new pipelines shall be scheduled and coordinated with the Engineering and Municipal & Industrial Operations Departments of Solano Irrigation District.

##### 1.04 SUBMITTALS

The Contractor shall submit the following:

- A. Three (3) copies of shop and fabrication drawings.

- B. Certificates of compliance with specified standards for PVC pipe and elastomeric gaskets.

#### 1.05 WARRANTY

- A. Contractor guarantees pipelines against defective workmanship, materials and against leakage for the one (1) year after the pipeline is accepted by the District. The Contractor shall repair all leaks and maintain the pipeline in a satisfactory operating condition during the above-specified period. Upon notice to the Contractor by the District of needed repairs, the Contractor shall undertake such repairs, including necessary dewatering, within forty eight (48) hours. Neither the guaranty nor the maintenance requirements shall apply to damage to the pipelines caused by an Act of God, negligence in the operation of the system, or acts of third parties.
  - 1. If the Contractor cannot comply with the forty-eight (48) hour requirement, the District will complete the repairs, which may include hiring another contractor, and bill the Contractor for the costs.

#### 1.05 MEASUREMENT AND PAYMENT

- A. Valve installation will be paid for at the applicable unit price bid therein in the Bid Schedule. The price shall include all materials and labor, including valve access wells where required, fabricating, furnishing trenching, placing, backfilling, companion flanges, bolts, testing, guaranty and maintenance, and all work required to complete the valve installation.
- B. Pipelines shall be paid for at the unit price per foot bid therefor in the Bid Schedule. Payment for main pipelines shall include pipe, fittings, specials, bends, tees, connections, magnetic warning tape, tracer wire, potholing, trenching, over-excavating, placing, boring, dewatering, shoring, bracing, bedding, concrete thrust blocks, backfill, compaction, testing, permits, inspection, cleanup, guaranty, maintenance and all other labor and materials required to construct the pipelines.
- C. Manifolds will be paid for at the applicable lump sum price bid therefor in the Bid Schedule. This price shall include all cost of fittings, butterfly valves, motor-operated butterfly valves, check valves, air and vacuum valves, insulating kits, materials, labor, fabricating, furnishing, placing, backfilling, concrete thrust blocks and encasements, testing, lining, coating, guaranty, and maintenance and all other work required to complete the manifolds to the paylines as indicated on the Drawings.
- D. Air and Vacuum Valve Assemblies will be paid for at the applicable unit price each as bid in the Bid Schedule. Said price shall include all materials and labor, valves, pipe well and lid, piping, ball valves, fabricating, furnishing, installing,

gravel backfill, guaranty and maintenance, and all other labor and materials required to complete the installation.

- E. Payment for backflow prevention assemblies, as required for temporary cross-connection to a potable water system, will be at the price per assembly in the Bid Schedule, and shall include all mechanical equipment, valves, pipes, concrete pads and anchors and enclosures.
- F. Payment for service connections assemblies will be at the unit price per assembly bid in the Bid Schedule. Said price shall include all costs of material and labor, horizontal service pipe from the main to the meter, bronze saddle, meter, meter box, lid, bronze corporation stop, grade box blocking, fittings, piping, fabricating, furnishing, trenching, placing, backfilling, testing, guaranty and maintenance, and all other work required to complete the water service. Said price shall include delivery of meters F.O.B. District warehouse.
- G. Payment for furnishing and installing guard posts, as required, will be made at the applicable unit price bid therefor in the Bid Schedule. This price shall include all costs of materials, equipment, labor and all appurtenances necessary to complete the installation.
- H. All labor and materials for which there is no item in the Bid Schedule shall be included in the unit price bid for the applicable size of pipe to which they are appurtenant.

## **PART 2 MATERIALS**

### **2.01 PIPE AND PIPE FITTINGS**

- A. Steel Pipe & Fittings:
  - 1. Pipe & Fittings: Steel pipe and fittings shall conform to AWWA C200 and shall be “Standard Wall” for that size of pipe or as indicated on the Drawings, in the Details, and Improvement Plans, if any. Welded steel pipe and fittings shall be electrically welded and fabricated from steel plate conforming to ASTM A283, Grade C or D, or ASTM A570, Grade 30 or 33. Seamless steel pipe and fittings shall conform to ASTM A53, and shall be Schedule 40, minimum. Fabrications shall conform to the configurations shown on the Drawings, in the Details, and Improvement Plans if any.
  - 2. Flanges for Steel Pipe & Fittings: Flanges to be fitted onto steel pipe and fittings shall conform to AWWA C207, Class D, and may be ring or hub type. All flanges shall be marked in accordance with Section 1.4 of AWWA C207. Blind flanges shall be flat faced. Nuts & bolts shall be ASTM A307, Grade B, and conform to AWWA C207, and shall be

galvanized as specified in ASTM A153. Gaskets shall be rubber, flat-faced,  $\frac{1}{8}$ " thick, suitable for potable water service and conforming to AWWA C207.

**B. Ductile Iron Pipe & Fittings:**

1. **Ductile Iron Pipe:** Ductile iron pipe shall conform to AWWA C151. Joints shall be flanged type per AWWA C110 or C115. Provide standard thickness interior cement-mortar lining per AWWA C104. Provide standard thickness exterior coal tar coating per AWWA C151 or fusion bonded epoxy lined and coated per AWWA C116.
2. **Ductile Iron Fittings:** Main pipeline fittings (including end caps, ells, tees and crosses) shall be ductile iron, conform to the requirements of AWWA C110 or C153, with a pressure rating of 150 psi or greater, for fittings and C111 for rubber gasket joints, and be compatible with AWWA C900 and C905 PVC pipe. Fittings shall have flanged or mechanical joints, conforming to AWWA C110 or C153 as applicable. Push-on joints are not acceptable. Nuts & bolts shall be ASTM A307, Grade B, conform to AWWA C110, Appendix A, and shall be galvanized as specified in ASTM A153. Gaskets for flanged joints shall be rubber, flat-faced,  $\frac{1}{8}$ " thick, suitable for potable water service and conforming to AWWA C110.
  - a. The interior of ductile iron fittings shall be coated with a cement mortar lining in accordance with AWWA C104. The exterior shall be coated with a petroleum asphaltic (coal tar) coating per AWWA C110 or C153, as applicable.
  - b. The fittings may be fusion bonded epoxy lined and coated per AWWA C116. The use of fusion bonded epoxy fittings requires the addition of two (2) washers for each bolt and nut pair. The washers are to be placed against the epoxy coating in order to distribute the bolt and nut force thereby minimizing epoxy cracking. If cracking does occur, the fitting shall be removed, properly prepared and repaired with Scotchkote 312, or as recommended by the powder epoxy manufacturer.

**C. Polyvinyl Chloride Pipe (PVC):**

1. **Non-potable PVC water pipe:** Water mains shall be PVC pressure pipe conforming to AWWA C900, Class 150, SDR18, and AWWA C905, Class 165, DR25, unless otherwise noted. Where called for, AWWA C900, Class 200, SDR14 shall be installed. PVC pipe shall be made of polyvinyl chloride compound 12454-B per ASTM D1784. PVC main pipe outside diameters shall be cast iron pipe size (IPS). PVC pipe shall be supplied in standard 20 foot lengths. Pipe joints shall be the bell-and-spigot type, self-centering, with O-ring elastomeric gaskets, conforming to

ASTM D3139 and F477. The gasket material shall conform to AWWA C-300.

2. Identification: Non-potable water pipe shall be purple in color. Provide “PW Purple Plus” by Pacific Western Extruded Plastics Company (PW Pipe) or equal. If “PW Purple Plus” pipe is unavailable, standard AWWA C900 or AWWA C905 may be used with the addition of a purple PVC sleeve and “CAUTION: RELCAIMED WATER – DO NOT DRINK” printed on the sleeve material.
3. Small Diameter Pipe: Miscellaneous small diameter PVC pipe shall conform to ASTM D1785. Schedule of pipe shall be as noted in the Details, and Improvement Plans if any, but not less than Schedule 40.
4. PVC Fittings: PVC fittings shall conform to ASTM D1784, and shall be a minimum of Schedule 40.

D. Polyethylene (PE) Pipe

1. 1" Diameter: PE pipe shall conform to AWWA C901-88, ASTM Designation D2239, PE 3408, SDR 7, and shall have a pressure rating of not less than 200 psi at 23°C. PE pipes one inch (1") in diameter shall be inside diameter (ID)-based iron pipe size (IPS).
2. Over 1" Diameter: PE pipe shall conform to ASTM Designation D2737, PE 3408, SDR 9, and shall have a pressure rating of not less than 200 psi at 23°C. PE pipes over one inch (1") in diameter shall be copper tubing size (CTS).
3. PE pipe shall not be used for pipelines larger than three inches (3") in diameter.
4. Packaging of polyethylene pipe: The pipe shall be coiled and packaged for protection against dirt and damage during shipment, handling and storage.

E. Brass Pipe: Where called for, provide seamless red brass pipe suitable for use in water service lines and plumbing, conforming to ASTM B43.

F. Pipe Couplings:

1. Mechanical Joint and Flanged Coupling Adapters: Flanges shall be supplied in accordance with AWWA C207. Compression ends of the adapter shall have a Dresser coupling type pack utilizing a wedge gasket for efficient sealing. Adapter bodies and end rings installed underground shall be ductile iron. Adapter bodies and end rings installed above ground may be fusion bonded epoxy lined and coated steel or ductile iron. Adapters shall be furnished with a shop coat compatible with the final field coating. Coatings must be suitable for direct burial. Bolts and nuts

shall conform to AWWA C111, Appendix B, and shall be galvanized as specified in ASTM Designation A-153. Gaskets shall be suitable for use with potable water and shall be suitable for the type of pipe being coupled. Anchor studs or retention rings are not allowed when coupling to PVC pipe. As shown on the Drawings, the flanged coupling adapters shall be Smith-Blair Style 912 or 913 or approved equal.

2. Compression Couplings: Compression couplings (including straight, transition, reducing and end cap types) shall be ductile iron. Gaskets shall be suitable for use with potable water and shall be suitable for the type of pipe being coupled. Bolts and nuts shall conform to AWWA C111, Appendix B.
3. Insulated Flanges and Couplings:
  - a. Insulation Points: Install an approved, electrically-insulating connection at all pipe connections where dissimilar coating or lining materials occur, and at connections to other appurtenances where shown in the Details or Improvement Plans.
  - b. Flange Insulation Kits: shall consist of a central gasket, bolt sleeves, insulated washers and steel washers. The central gasket shall be reinforced. Insulating materials shall have sufficient strength to operate at the pressure rating of the pipe to which they will be coupled, and shall be suitable for direct burial. Flange insulating kits shall be as manufactured by M&P Flange & Pipe Protection Inc., the PSI Company, or approved equal.
  - c. Insulated Mechanical Couplings: The coupling shall be supplied with insulating boots. Insulating materials shall have sufficient strength to operate at the pressure rating of the pipe to which they will be coupled, and shall be suitable for direct burial. Insulated couplings shall be Romac style IC501, Smith-Blair style 416, or approved equal.
4. Mechanical Couplings: Where shown on the Drawings, the mechanical couplings shall be Smith-Blair 441 series, Romac 501 series, or approved equal, with joint harness assemblies. The pipe stop shall be removed. The thickness of the middle ring (sleeve) shall not be less than the thickness of the adjoining pipe. The middle ring (sleeve) and followers shall be coated with fusion bonded epoxy. The bolts and nuts shall be galvanized as specified in ASTM Designation A-153.

## 2.02 VALVES

- A. General: All sectionalizing valves four (4) inches and larger shall be flanged butterfly valves per subsection 2.02.B. All below ground sectionalizing valves smaller than four (4) inches shall be flanged gate valves per subsection 2.02.D.

All valves shall have a full-opening flowway equal to the nominal diameter of the connecting pipe. Valve installations shall be complete with all gaskets, bolts and all else required to complete the valve in an operating, watertight condition. Valves shall be furnished with companion flanges. Valves shall have all ferrous interior surfaces epoxy coated in conformance with the provisions of AWWA C550, with Keysite Epoxy No. 740, Scotchkote Epoxy No. 306, or approved equal, suitable for use in potable water. Valves located underground shall have a coal tar coating in accordance with applicable provisions of AWWA C203. All valves located above ground shall be furnished with removable handwheels. All below-ground valves shall be provided with two inch (2") square operating nuts and have two (2) o-ring stem seals. If the operating nut on below-ground valves is deeper than 60", then a valve nut extension shall be installed. Valves shall open when turned counterclockwise, that is, when turned to the left.

- B. Butterfly Valves: All butterfly valves shall conform to the applicable provisions of AWWA C504, and be flanged (short body), and not of the wafer type. Valves shall be Class 150 pressure rating, show no leakage under 200 psi of pressure, and shall be as manufactured by Pratt or approved equal.
- C. Ball Valves: All ball valves shall, in general, conform to the applicable provisions of AWWA C507. Ball valves shall have bronze bodies with threaded ends, full-ported chrome-plated brass balls, virgin PTFE (Teflon) seats and stem packing, and brass stems with adjustable stem packing nuts threaded into the body. Ball valves shall have a pressure rating the same as or greater than that of the pipeline at the point of installation. Ball valves shall be Watts series FBV-3 or approved equal.
- D. Gate Valves: All gate valves shall have a non-rising stem, shall be bronze mounted, shall have a Class 150 pressure rating, and conform to the applicable provisions of AWWA C500. Below-ground gate valves shall be furnished with cast iron discs and flanged bodies suitable for buried installation, resilient seats, bronze mounts, and 2" square operating nuts. Double disc styles are unacceptable. They shall be as manufactured by American-Darling Company, Mueller Company, M&H, or approved equal. Above-ground gate valves shall have threaded bronze bodies and shall be provided with a removable handwheel.
- E. Check Valves: All check valves shall conform to the applicable provisions of AWWA C508. Check valves shall be iron body, swing type, flanged and bronze fitted, and shall be furnished with an external lever and single weight or spring. The seating ring of the valve and disc shall be bronze. The valve body and disc so proportioned that they will provide a passage fully equal in area of the nominal pipe size of the valve, when the valve is in the wide-open position. Check valves shall have a pressure rating equivalent to that of the pipeline of which they are to become a part. The valves shall be shop tested to a pressure of 150 psi, and under this test there shall be no leakage in any part of the valve assembly nor shall any part be permanently deformed. Check valves shall be as manufactured by Eddy-Iowa, Bailey, or approved equal.

- F. Air Release & Vacuum Valves (ARV): All air release and vacuum valves for ARV installations shall have the same pressure rating as the pipeline at the point of installation. Above-ground piping, below-ground piping and housing shall be as shown in the Standard Details. Air release and vacuum valves shall be Bernad Model 02-ARC-P.

## 2.03 FIRE HYDRANTS AND APPURTENANCES

- A. In general, fire hydrants are not permissible on non-potable pipelines.
- B. On a case-by-case basis, wharf hydrants may be allowed with approval from the District, but shall not be apart of a fire suppression design.

## 2.04 SERVICE LINE FITTINGS

- A. Service Saddles: Saddles shall be sized for use on cast iron pipe size AWWA C900 PVC mains. Saddle bodies shall be the bronze, stainless steel double-strap type. Saddles shall be provided with female iron pipe thread outlets per AWWA C800. Assembly hardware shall be silicon bronze or stainless steel. The gasket shall be of material suitable for use with potable water.
- C. Bronze Fittings and Stops: Bronze tees, ells, reducers, nipples, and stops shall conform to the requirements of AWWA C800. All ¾" and 1" fittings for connecting to IPS PE pipe shall be Mueller "Insta-Tite" adapters. Fittings larger than 1" in size for connecting to CTS PE pipe shall be Ford "Pack Joint", Mueller 110 Compression Connector or approved equal. Corporation stops shall have male iron pipe threads. Angle meter stops shall be bronze and lockable.

## 2.05 WATER METERS

- A. Consistent "Standard" Flow Water Meters: Meters on non-potable water services shall be bronze, conform to AWWA C700 and be Sensus PMM meter or Hersey MVR Vertical Turbine meter. Provide Radio-Read System equipment including a meter transceiver unit (MXU) model 520R Pit Set Unit and box lid-mounted transmitter. Meters are to read in cubic feet, and are to be purchased and installed by the District at the Developer's expense.
- B. Variable Flow Water Meters: Meters on non-potable water services shall be bronze, conform to AWWA C700 and be Hersey MVR Vertical Turbine meter. Provide Radio-Read System equipment including a meter transceiver unit (MXU) model Sensus 520R Pit Set Unit and box lid-mounted transmitter. Meters are to read in cubic feet, and are to be purchased and installed by the District at the Developer's expense.

## 2.06 BACKFLOW PREVENTION ASSEMBLIES

- A. Backflow preventer assemblies are only required for temporary cross-connection to the city potable water system. The connection may require additional fees,

permits and/or agreements with the city.

- B. The backflow preventer assembly will be removed after the non-potable water system has been accepted by the District and the system is being provided by a District water source.
- C. The design and construction requirements shall meet the city requirements.
- D. Only assemblies that have been approved for use by the California Department of Health Services (DHS) may be used. Only the USC Foundation for Cross Connection Control and Hydraulic Research is recognized and acceptable to DHS. The District Engineering Department keeps a copy of the list of approved assemblies.

## 2.07 COATINGS, LININGS & PAINT SYSTEMS

- A. Fusion Bonded Epoxy Lining and Coating Systems: Fusion bonded epoxy systems shall conform to AWWA C213. The minimum thickness shall be 20 mils.
- B. Epoxy Lining Systems: Epoxy lining systems shall conform to AWWA D102, Section 3.2, "Inside Paint System No. 1 (Epoxy)." Per AWWA D102-78, the dry film thickness for Inside Paint System No. 1 is 8 mils. The minimum thickness shall conform to latest edition of AWWA D102.
- C. Tape Coating: Tape coatings are unacceptable for above-ground piping. Continuation of below-ground tape coating to a minimum distance above the ground line as specified is acceptable.
  - 1. Field-Applied Tape Coating: Field-applied tape coatings shall conform to AWWA C209. The minimum thickness shall be 20 mils, and the minimum overlap shall be ½ inch.
  - 2. Factory-Applied Tape Coating: Factory-applied tape coatings shall conform to AWWA C214. The minimum tape thickness shall be 50 mils.
- D. Above-Ground Painting:
  - 1. Piping: Above-ground epoxy painting shall conform to AWWA D102, Section 2.1, Outside Paint System No. 1, special color, and shall have a prime coat of 3.0 mils self-priming epoxy. The finish coat shall be a two-component aliphatic polyurethane of 3 mils. Color shall be as specified herein, in the Standard Details, or in the Improvement Plans. Intermediate paint coats shall be tinted to provide discernable contrast in the subsequent coat.
  - 2. Miscellaneous Metal: Unless otherwise specified herein, in the Standard Details, or in the Improvement Plans, piping and exposed metal called to

be painted on site shall be painted with Devco "Bar-Rust 233H" multi-purpose epoxy coating, buff color (Cat. No. 233H1642), or approved equal.

- E. Galvanized Lining and Coating: Galvanized lining and coating shall conform to ASTM A120.

## 2.08 MANIFOLDS

- A. Manifolds shall include all piping, butterfly valves, motor-operated butterfly valves, check valves, air and vacuum valves, flanges, mechanical couplings, joint harnesses, gauges, taps, cocks, bolts, pipe supports, flanged coupling adapters, insulating kits where required, concrete thrust blocks and encasement, and all other fittings and materials required to complete the manifolds in a watertight, operating conditions.
- B. Reinforcement of openings shall conform to Section VIII of the ASME Boiler and Pressure Vessel Code.
- C. The Contractor shall furnish and install companion flanges, gaskets, and bolting. Bolts and nuts shall be stainless steel with two stainless steel washers installed one each under the bolt head and nut. The Contractor shall also furnish and install flanges, mechanical couplings and joint harness lugs required to join pump discharges to the manifolds.

## 2.09 MISCELLANEOUS MATERIALS

- A. Polyethylene (PE) Film: Polyethylene film for encasing (wrapping) ductile iron fittings, nuts and bolts, and miscellaneous metals shall conform to the requirements of AWWA C105. Minimum film thickness is 20 mils.
- B. Pipeline Warning Tape: Warning tape shall be metallic, 12" wide, 4 mil thick polyethylene. Tape shall be colored, and labeled with black lettering as follows:

Tape Color: Purple

Tape Labeling: CAUTION - NON-POTABLE WATER LINE BURIED BELOW

- D. Reinforcing Bars: Reinforcing steel shall conform to ASTM Designation A615 Grade 40 for deformed and plain billet steel bars for concrete reinforcement.
- E. Concrete: Concrete shall use Portland cement conforming to ASTM C150, Type II, and have a minimum cement content of 5 sacks per cubic yard. Minimum relative compressive strength shall be 3,000 psi after 28 days.
- F. Valve and Meter Boxes:

All valve and meter boxes shall be provided with "purple" lids for non-potable or

reclaimed water identification. Each box shall be provided with “NON-POTABLE” or “NON-POTABLE WATER” cast into the lid. Each meter, air & vacuum valve and blowoff shall be identified with a purple plastic tag “Warning Non-Potable Water Do Not Drink Agua No Potable” furnished and installed by the District at the Developer’s expense.

1. Air Release Valve (ARV) Boxes: provide Christy Fibrelyte model FL-36 or approved equal, with Fibrelyte extensions sufficient to provide required depth. Provide model Placer Waterworks model PW/AE3618-M cover with factory applied epoxy coating, purple in color.
  2. Water Meter Boxes: provide Christy Fibrelyte box or approved equal, with Fibrelyte extensions sufficient to provide required depth. Provide Fibrelyte box lid with round opening for Sensus "Radio-Read" box lid-mounted MXU transmitter. See Standard Details for size required.
  3. Water Valve Boxes: Christy Model G-5 utility box with cast iron round traffic cover marked “NON-POTABLE” as shown in the Standard Details, or approved equal.
  4. Blowoff Boxes: Christy Model G-12 utility box with cast iron traffic cover marked “NON-POTABLE” as shown in the Standard Details, or approved equal.
- G. Concrete Grade Boxes: On a case-by-case basis, with the approval of the Water and Power Operations Manager and Engineer, concrete boxes, extensions and lids may be substituted for fiber reinforced plastic boxes of the same size. All other requirements shall be the same as those specified for valve and meter boxes in section 2.10.F, above.
- H. Grade Box Blocking: Redwood shall be placed under all grade boxes, available locally. Their size and length shall be as shown in the Standard Details. If not specified, the minimum nominal size shall be two by four (2"x4") with the length to extend two inches (2") beyond each end of the box.

## **PART 3 EXECUTION**

### **3.01 WORKMANSHIP STANDARDS**

- A. The size and configuration of the various components of the water system shall be as indicated herein, in the Standard Details, and in the approved Improvement Plans, if any. The work shall be completed in a workmanlike manner to insure an operable and watertight condition.

### **3.02 WATER & NON-POTABLE SEPARATION REQUIREMENTS**

- A. Installation of non-potable pipelines adjacent to potable water mains shall conform to the State of California Department of Health Services "Water Main

Separation", adopted March 3, 2008. See the Standard Details. Provide minimum clearances between non-potable appurtenances and potable services to residence or business. Installation of non-potable pipelines and potable water mains in the same trench shall be in accordance with the Uniform Plumbing Code.

### 3.03 TRENCH EXCAVATION AND BEDDING

- A. Trench Safety Requirements: the Contractor shall adhere to the Trench Safety Plan outlined in Section 00700.6.10.F.
- B. Refer to Section 02300 – Earthwork, subsection 3.12 – Trenching for Pipe and subsection 3.13 – Backfill of Pipe.

### 3.04 TRENCHLESS PIPE INSTALLATION

- A. Pipelines may be installed using trenchless technology, refer to Section 02246. The Contractor shall confirm the location and depth of all utilities to be crossed by pipelines installed using trenchless techniques. Said utilities, if damaged, shall be repaired to the satisfaction of the utility owner at the Contractor's expense, and no additional payment will be allowed for such repairs.

### 3.05 PIPELINE INSTALLATION

- A. General: Contractor shall provide all labor, material, and equipment to install all pipe and other appurtenant apparatus required to complete the non-potable water pipeline in an operating, watertight condition. Contractor shall furnish all supports, bracing, other materials and all work required for hauling, unloading, distributing, trenching, protecting, dewatering, placing, backfilling, cleaning and testing of the pipeline and appurtenances, and for resurfacing of roads and jobsite cleanup.
- B. Handling of Materials: During handling, loading, transportation and unloading, every precaution shall be taken to prevent injury to the pipe, fittings, valves and appurtenances. Coatings, linings and finishes shall be protected from damage. The manufacturer's recommendations for handling materials shall be followed in all details. No pipe shall be dropped or allowed to roll down skids without proper restraining ropes. During transportation, storing and stringing, each joint of pipe shall rest upon suitable pads, strips, or blocks as recommended by the manufacturer and shall be securely wedged or banded into place. Materials shall be carefully lowered into the trench. Any materials damaged beyond repair, in the opinion of the Engineer, shall be replaced by, and at the expense of, the Contractor.
- C. Cleanliness and Cleaning During Construction:
  - 1. All materials shall be thoroughly clean before installation. The pipelines must be kept clean and dry during construction. The Contractor shall take precautions to prevent contamination of the interior of pipes, fittings

valves and appurtenances by dirt, debris and animals entering the pipe.

2. If dirt, debris or animals have entered into pipe, it/they shall be removed by the Contractor. If the main is flooded during construction, the Contractor shall dewater the pipeline before continuing. After construction is completed, the main shall be flushed prior to its final connection.
3. At the close of each work day and when pipe installation is not in progress, exposed ends of the pipeline shall be protected with approved temporary bulkheads furnished and installed by the Contractor. Temporary bulkheads shall not be removed until the trench is dry. Before work is stopped for the day, all joints shall be completed with the exception of joints adjoining structures.

D. Connections to Existing Mains:

1. Main-line connections shall be made by installing standard flanged ductile iron fittings in the existing mains where shown on the plans. "Hot tap" connections are not permitted except for service connections up to two inches (2") in diameter.
2. The Contractor is to coordinate the sequence and method of connection with the Engineer before making the connection. The sequence and method of connection are subject to the approval of the Engineer.
3. The Contractor shall notify all affected users in writing at least 24 hours in advance of service interruption. The Contractor shall notify the Engineer, at least 48 hours in advance to schedule valve closures for service interruption. Only District crews are to operate existing valves.

E. Pipe Laying:

1. The pipe shall be placed firmly in the center of the trench and true to line and grade with no visible change in alignment at any joint, unless the alignment is shown to be curved in the Improvement Plans. Joint deflection for curved alignments shall not exceed 80% of the manufacturer's recommended values. On slopes greater than ten percent (10%) the pipe bells shall be pointed up-grade and laying shall proceed up-grade.
2. The pipe joints shall be assembled according to the manufacturer's recommendations, these Specifications, and as directed by the Engineer. The use of power equipment such as backhoes or excavators shall be prohibited unless approved by the Engineer. Regardless of the method used the joints shall be watertight. If it is necessary that a pipe be moved or that the alignment be adjusted after it has been installed, it shall be removed and rejoined as was accomplished in the original installation.

3. Except as required for backfilling, the Contractor shall prohibit walking or working upon the pipe until backfilling of the trench has been completed. The Contractor shall provide temporary bridging over pipe trenches where it is necessary to provide crossings for workers and equipment, or access roads.
4. The Contractor shall take all necessary precautions to prevent the pipe from floating due to water entering the trench from any source, shall assume full responsibility for any damage and shall, at his own expense, restore and replace the pipe to its specified condition and grade if it is displaced due to flotation.

F. Pipe Bedding:

1. Comply with subsection 3.13 – Bedding and Backfill of Pipe, of Section 02300 - Excavation.
2. All pipe, specials and fittings shall be bedded in sand. The bedding shall be to the dimensions as shown in the Drawings and Standard Specification Details. The Contractor shall use extreme care in placing the sand under the haunches to assure that all spaces are filled under and about the pipe. The sand bedding shall be compacted to not less than 70% relative density as determined by ASTM D-4253. Jetting of water pipe bedding is not permitted.

G. Steel Pipe

1. Field Welding Steel Pipe: field welding of pipe joints and attachments shall conform to AWWA C206. If previously coated and/or lined, field welded joints shall be recoated and lined with approved coating and lining systems per the manufacturer's recommendations.
2. Below-Ground Coatings and Encasement: refer to subsection 2.08 for acceptable materials. All buried steel piping, fittings and fabrications shall be lined and coated. Steel pipe and fittings shall be tape wrapped per subsection 2.08.C to a point at three inches (3") above final grade. Brass pipe and bronze fittings shall be tape wrapped per subsection 2.08.C to one inch (1") above and below the concrete when passing through a concrete pad. An electric holiday detector shall be passed about the entire circumference of tape-coated pipe to locate holidays and pinholes after coating and before installation. Any defective coating shall be repaired and retested. Fittings, piping and miscellaneous steel that will have concrete support pads or thrust blocks cast next to or around them shall be polyethylene encased per AWWA C105 using PE film per subsection 2.10.A. Fittings shall be clean of pipe bedding material, soil, etc., prior to PE encasement. Below-ground nuts and bolts shall be PE film encased per subsection 2.10.A, or tape wrapped per subsection 2.08.C. Ends of the PE film shall be taped closed around the covered materials.

3. Above-Ground Painting: refer to subsection 2.08 for acceptable materials. All above ground piping, fittings, and fabrications shall be painted with industrial primer and enamel unless otherwise noted. Color shall be as specified. Before painting, all piping shall be cleaned and free of mill scale. Paint shall be applied per the manufacturer's recommendations, and shall be checked for holidays and pinholes by an approved method. Brass and stainless steel hardware shall not be painted unless otherwise specified.
4. Linings: refer to subsection 2.08 for acceptable materials. All piping, couplings and fittings three inches (3") and larger shall be lined. All piping, couplings and fittings two and one-half inches (2½") and smaller shall be red brass piping or bronze fittings and require no additional coating unless specified in the Standard Details or by the Engineer.
5. Manifolds: All manifolds and piping shall be lined and coated with fusion-bonded epoxy as shown on the drawings. All exposed piping, fittings, and valves shall be painted after the field installation and testing have been completed. All piping shall be cleaned and free of mill scale. All exposed exterior surfaces shall be painted in accordance with AWWA D-102, Section 2.2 Outside Paint System No. 1, special color, and shall have one priming epoxy coat of 3.0 mils. The finish coat shall be a two-component aliphatic polyurethane of 3.0 mils. The lining, coating and exterior painting shall be applied per the manufacturer's recommendations and checked for holidays and pinholes by an approved method.

#### H. PVC Main Pipelines

1. Elastomeric gaskets for PVC joints, supplied loose, shall be stored in a cool, well-ventilated place, and shall not be exposed to the direct rays of the sun, until immediately before joint assembly.
2. The joints shall be lubricated and assembled in accordance with the manufacturer's recommendations. There shall be no pulling of joints unless shown in the plans or approved by the Engineer, and shall comply with the manufacturer's recommendations.
3. Care shall be taken in fitting the pipe together to avoid twisting or otherwise displacing or damaging the gasket. After the joint has been assembled, the position of the gasket shall be verified by passing a feeler gauge around the complete circumference of the joint. If the gasket is "fish-mouthed" or otherwise displaced, the joint shall be disassembled, a new gasket installed, the pipe relaid, and the position of the gasket rechecked.
4. There shall be no service or appurtenance connections within two (2) feet of a pipe joint, minimum, or as directed by the Engineer.

5. No rubber-gasket joint shall be encased in concrete.

I. Main Fittings & Valves

1. Fittings shall be supported independently of the pipe. Temporary supports under fittings or under pipe adjoining fittings will not be permitted. Permanent supports under fittings may be redwood blocks or concrete foundations approved by the Engineer.
  - a. Temporary supports may be used during the curing period of concrete foundations. The supports must be constructed to either become an integral part of the foundation or outside of the required foundation area, as directed and approved by the Engineer.
2. Preassembling flanged fittings, steel fittings and adjoining pipe, before installation in the trench will be permitted. The bolting shall be drawn up evenly around the periphery of the flange so as to ensure even pressures and required torque on the gasket before lowering into the trench and connecting to the pipeline. The contractor, at no additional expense, shall provide adequate labor force, equipment and harnessing required to install the preassembled facilities in a safe and efficient manner or as directed by the Engineer.
3. Fittings shall be polyethylene encased per AWWA C105 using PE film. No joint shall be encased in concrete. If necessary the Contractor shall use long or special fittings to comply with this requirement. Fittings shall be clean of pipe bedding material, soil, etc., prior to PE encasement. Ends of the PE film shall be taped closed around the covered materials.
4. Valves shall be set plumb with operating nuts installed on the side of the valve closest to the curb. Provide a valve box at each valve per the Standard Details.

3.06 THRUST BLOCKS

- A. Concrete thrust blocks are required at all angle points, tees and terminal points of the pipeline. Thrust block configurations shall be of the configuration indicated on the drawings or the Standard Details. Thrust blocks shall not cover joints. If necessary the Contractor shall use long or special fittings to comply with this requirement.
- B. Thrust blocks will be unreinforced concrete placed against undisturbed earth as shown in the Standard Details. When the site has been over excavated, thrust blocks may be cast against backfill approved by the Engineer which is mechanically compacted to ninety-five percent (95%) relative compaction. The compaction shall be verified by an outside agency and the results submitted to the Engineer for approval.

- C. The thrust blocks shall be centered about the center line of the joint and the pipe, shall have a minimum dimension parallel to the pipe centerline of one foot (1'), shall be equal in width to the pipe trench, and extend to six inches (6") below the bottom and above the top of the pipe.
- D. Concrete thrust blocks shall be cured one (1) day before the pipeline may be filled with water and three (3) days before the pipeline may be pressurized.

### 3.07 TRENCH BACKFILL

- A. Warning Tape: Metallic warning tape shall be placed in the same trench, directly over and not more than 12" above all main pipelines, laterals, turnouts and appurtenances installed by open-trench method.
- B. Tracer Wire: If required by the Engineer, comply with Section 02519 – Conductive Trace Wire for Nonmetallic Pipe Installation and the Standard Details.
- C. Backfilling and Compaction: Comply with Section 02300 – Earthwork. Compaction of the backfill material shall be as shown in the Standard Details. The Contractor shall use extreme care when compacting the backfill in the vicinity of the pipe to avoid damaging the pipeline. Jetting of trench backfill is not permitted.

### 3.08 TRENCH RESURFACING

- A. Comply with Section 02740 – Asphaltic Concrete Paving and the Standard Details.

### 3.09 APPURTENANCE INSTALLATION

- A. Backflow Prevention Assemblies: all backflow prevention assemblies shall be tested immediately after they are installed. Testing shall be done by the City, and Contractor shall give 24 hours advanced notice of readiness for testing. Backflow preventers shall be installed per the City's Standard Specifications, latest revision.
- B. Air & Vacuum Valve (ARV) and Blowoff Installation: Install ARVs and blowoffs where shown in the Improvement Plans, per the Standard Details. ARV and blowoff installations shall include connection of the installation to the pipeline including reinforcement if required, bronze ball valves, piping and all else required to complete the installation in an operating, watertight condition. ARVs shall not be installed below ground level.
- C. Service Connections: Install service connections as shown in the Standard Details at the locations shown in the Improvement Plans. The minimum service pipe size is one inch (1"). Trenches for service pipes shall be excavated, backfilled and resurfaced per these Standard Specifications. Trenchless

installation is preferred under existing paved surfaces, and may be used in any location. PE pipe shall be installed in accordance with applicable provisions of AWWA C901. Adjacent taps into the water main shall be separated by at least one foot (1') and connections shall not be closer than two feet (2') from pipe joints or as directed by the Engineer or the end of the main pipe.

- D. Guard Posts (Bollards): The Contractor shall provide all labor, materials and equipment required to furnish and install the guard post installations as indicated on the drawings and the Standard Details.

### 3.10 FILLING PIPELINES

- A. Connections between new and existing pipelines shall be isolated with a control valve. The rate of filling the new pipeline shall be limited to 500 gpm to avoid stirring sediments in the existing distribution system. Control valves shall be opened and closed slowly to minimize pressure surges in the pressurized existing pipelines. Forty eight (48) hours advanced notice will be given by the Contractor to the Engineer, which will notify the District Operations Department of the planned filling.

### 3.11 FIELD HYDROSTATIC TESTING

- A. In addition to any tests required by AWWA, ASTM and any other standard Specifications referred to in these Specifications, and in addition to any specified shop or plant hydrostatic tests for pipe, a field hydrostatic test shall be required for all pipelines and appurtenances. The Contractor shall provide all labor, equipment, materials, bulkheads and recently-calibrated measuring apparatus required to make the test. The District shall not be responsible for any damage, including damage to the pipeline or appurtenances, due to testing.
- B. Preparation for Testing:
  - 1. Prior to the start of testing, the Contractor shall submit the proposed testing procedure, in writing, to the Engineer for review.
  - 2. By necessity, installation of all valves, fittings, appurtenances, concrete thrust blocks and backfill shall be completed so that testing may be undertaken.
  - 3. Temporary bulkheads furnished and installed by the Contractor may be used with prior approval. After completion of the test, the Contractor shall remove said bulkheads. The Contractor may test against closed sectionalizing valves.
  - 4. The pipeline to be tested shall be slowly filled with water and left under normal operating pressure for at least 24 hours prior to the start of testing. Air shall be expelled from and through all services, blowoffs and ARVs.

5. The Contractor may fill the pipeline to check for leaks before backfilling the trench, but must repair any resulting damage or displacement to the pipeline. Said pipeline filling before trench backfilling will not satisfy the hydrostatic testing requirement.
  6. Testing shall be done as soon as possible after the completion of the pipeline, but in no event sooner than three (3) days after the placement of any concrete thrust block that will be subject to hydrostatic pressure during a test.
- C. Test Sections: Pipelines may be tested in one length, between valves, or between bulkheads, as approved. All appurtenances and service lines shall be considered as part of the main pipeline for the purpose of hydrostatic testing. All exposed pipe, appurtenances and services shall be examined during the pressure test.
- D. Test Pressure: Test pressure shall be 150 pounds per square inch (150 psi) measured at the low point in the test section, unless otherwise noted.
- E. Test Duration: The test shall continue for twenty four (24) hours, after which time the amount of leakage and pressure loss shall be observed by the Engineer.
- F. Allowable Leakage: Makeup water to replace leakage will be accurately metered as it is added to the pipeline. Under the specified test conditions, the maximum leakage shall not exceed the following amounts or as outlined in AWWA C-605:
1. PVC Distribution Pipe: ten (10) gallons per day, per inch of pipeline diameter, per mile of pipe.
  2. Steel Pipe with Welded Joints: no leakage.
- G. Acceptance and Repair of Pipelines: Regardless of the actual leakage from the pipe, the Contractor shall repair all visible leaks. Cracked or defective pipe, fittings, valves, and appurtenances shall be replaced. Contractor shall continue testing and repair of leaks until the actual leakage is reduced to or below the allowable leakage for 24 hours. If leakage persists after repair, fittings, valves, appurtenances, the pipe joint, joints, or entire pipeline shall be removed and replaced with new material and retested. Leaks shall be repaired by and at the expense of the Contractor.

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## SECTION 02516

### DOMESTIC POTABLE WATER SYSTEMS

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. The Contractor shall provide all labor, material, equipment and install all pipes, specials, fittings and all valves, hydrants and other appurtenant apparatus, and perform all operations required to complete the water system in an operating, watertight condition. The Contractor shall furnish all supports, bracing, other materials and all work required for pipe hauling, unloading, distributing, trenching, protecting, dewatering, placing, backfilling, disinfecting, cleanup and testing of the water system.
- B. The size and configuration of the various components of the water system shall be as indicated herein, in the Standard Details, and in the approved Improvement Plans, if any.
- C. All construction of the District water system shall conform to the latest adopted editions of the AWWA Standards and the District Standards in effect at the time of improvement plan or change order approval or revision, unless otherwise noted in this Section. The latest edition of the California Waterworks Standards, being the California Code of Regulations, Title 22, Chapter 16, in effect at the time of improvement plan or change order approval or revision, also applies.

##### 1.02 RELATED SECTIONS

- A. Section 01100 – General Requirements
- B. Section 02300 – Earthwork
- C. Section 02519 – Conductive Trace Wire for Nonmetallic Pipe Installation
- D. Section 02740 – Asphaltic Concrete Paving

##### 1.03 SUBMITTALS

The Contractor shall submit the following:

- A. Paint color charts for selection by the District.
- B. Three (3) copies of shop and fabrication drawings.
- C. Certifications from the manufacturer for all brass and bronze products in compliance with the Safe Drinking Water Act.

- D. Certificates of compliance with specified standards for PVC pipe and elastomeric gaskets.
- E. Certification that interior coatings for pipes, fittings and valves are acceptable for potable water supplies.

#### 1.04 WARRANTY

- A. Contractor guarantees pipelines against defective workmanship, materials and against leakage for the one (1) year after the pipeline is accepted by the District. The Contractor shall repair all leaks and maintain the pipeline in a satisfactory operating condition during the above-specified period. Upon notice to the Contractor by the District of needed repairs, the Contractor shall undertake such repairs, including necessary dewatering, within forty eight (48) hours. Neither the guaranty nor the maintenance requirements shall apply to damage to the pipelines caused by an Act of God, negligence in the operation of the system, or acts of third parties.
  - 1. If the Contractor cannot comply with the forty-eight (48) hour requirement, the District will complete the repairs, which may include hiring another contractor, and bill the contractor for the costs.

#### 1.05 MEASUREMENT AND PAYMENT

- A. Valve installation will be paid for at the applicable unit price bid therein in the Bid Schedule. The price shall include all materials and labor, including valve access wells where required, fabricating, furnishing trenching, placing, backfilling, companion flanges, bolts, testing, guaranty and maintenance, and all work required to complete the valve installation.
- B. Pipelines shall be paid for at the unit price per foot bid therefor in the Bid Schedule. Payment for main pipelines shall include pipe, fittings, specials, bends, tees, connections, magnetic warning tape, tracer wire, potholing, trenching, over-excavating, placing, boring, dewatering, shoring, bracing, bedding, concrete thrust blocks, backfill, compaction, testing, permits, inspection, disinfection, cleanup, guaranty, maintenance and all other labor and materials required to construct the pipelines.
- C. Manifolds will be paid for at the applicable lump sum price bid therefor in the Bid Schedule. This price shall include all cost of fittings, butterfly valves, motor-operated butterfly valves, check valves, air and vacuum valves, insulating kits, materials, labor, fabricating, furnishing, placing, backfilling, concrete thrust blocks and encasements, testing, disinfecting, lining, coating, guaranty, and maintenance and all other work required to complete the manifolds to the paylines as indicated on the Drawings.
- D. Air and Vacuum Valve Assemblies will be paid for at the applicable unit price

each as bid in the Bid Schedule. Said price shall include all materials and labor, valves, pipe well and lid, piping, ball valves, fabricating, furnishing, installing, gravel backfill, guaranty and maintenance, and all other labor and materials required to complete the installation.

- E. Payment for backflow prevention and DCDA assemblies will be at the price per assembly in the Bid Schedule, and shall include all mechanical equipment, valves, pipes, concrete pads and anchors, bollards and enclosures.
- F. Hydrant assemblies will be paid for at the applicable unit price bid in the Bid Schedule. The payment for the horizontal pipe for the hydrant branch shall be included in the hydrant installation. This price shall include all costs of materials and labor, fire hydrant, butterfly valve, valve box, lid, tee, flanged coupling adapter, bury, thrust block, concrete pad, PVC piping, painting, coating, fabricating, furnishing, trenching, placing, backfilling, testing, guaranty and maintenance and all other work required to complete the hydrant installation.
- G. Payment for sampling station assemblies will be at the price per assembly bid in the Bid Schedule and shall include all mechanical equipment, valves, pipes, concrete pads, anchors, and enclosure to complete the installation in a watertight manner.
- H. Payment for service connections assemblies will be at the unit price per assembly bid in the Bid Schedule. Said price shall include all costs of material and labor, horizontal service pipe from the main to the meter, bronze saddle, meter, meter box, lid, bronze corporation stop, grade box blocking, fittings, piping, fabricating, furnishing, trenching, placing, backfilling, disinfecting, testing, guaranty and maintenance, and all other work required to complete the water service. Said price shall include delivery of meters F.O.B. District warehouse.
- I. Payment for furnishing and installing guard posts will be made at the applicable unit price bid therefor in the Bid Schedule. This price shall include all costs of materials, equipment, labor and all appurtenances necessary to complete the installation.
- J. All labor and materials for which there is no item in the Bid Schedule shall be included in the unit price bid for the applicable size of pipe to which they are appurtenant.

## **PART 2 MATERIALS**

### **2.01 NO-LEAD BRASS SPECIFICATION**

- A. All brass pipe, bronze valves & fittings and meters that come in contact with potable water shall be designated as “No Lead” or “Enviro-Brass”.
- B. The brass alloy used for all surfaces coming in contact with potable water shall be UNS/CDA number C89833 as listed in ANSI/AWWA C800-05

Standard and the products produced with this alloy shall meet the ANSI/NSF-61 Standard, complying with the Safe Drinking Water Act (AB 1953).

- C. The material composition of UNS/CDA number 89833 shall be 87.0-91.0% Copper, 4.0-6.0% Tin, 0.10% max. Lead, 2.0-4.0% Zinc and 1.7-2.7% Bismuth or per the current composition standards.
- D. All brass pipes, bronze valves & fittings, meters shall be certified by an ANSI accredited test lab per ANS/NSF Standard 61, Drinking Water Components – Health Effects, Section 8. Proof of certification must be submitted to the District.
- E. The letters “NL” for no lead or “EB” for enviro-brass must be cast into the main body for proper identification. Stamped lettering is unacceptable.
- F. Brass and bronze components that do not come in contact with the potable water shall meet the requirements of AWWA C800-05, ASTM B62 and ASTM B584, using UNS/CDA number C83600.

## 2.02 PIPE AND PIPE FITTINGS

### A. Steel Pipe & Fittings:

- 1. Pipe & Fittings: Steel pipe and fittings shall conform to AWWA C200 and shall be “Standard Wall” for that size of pipe or as indicated on the Drawings, in the Details, and Improvement Plans if any. Welded steel pipe and fittings shall be electrically welded and fabricated from steel plate conforming to ASTM A283, Grade C or D, or ASTM A570, Grade 30 or 33. Seamless steel pipe and fittings shall conform to ASTM A53, and shall be Schedule 40, minimum. Fabrications shall conform to the configurations shown on the Drawings, in the Details, and Improvement Plans, if any.
- 2. Flanges for Steel Pipe & Fittings: Flanges to be fitted onto steel pipe and fittings shall conform to AWWA C207, Class D, and may be ring or hub type. All flanges shall be marked in accordance with Section 1.4 of AWWA C207. Blind flanges shall be flat faced. Nuts & bolts shall be ASTM A307, Grade B, and conform to AWWA C207, and shall be galvanized as specified in ASTM A153. Gaskets shall be rubber, flat-faced,  $\frac{1}{8}$ " thick, suitable for potable water service and conforming to AWWA C207.

### B. Ductile Iron Pipe & Fittings:

- 1. Ductile Iron Pipe: Ductile iron pipe shall conform to AWWA C151. Joints shall be flanged type per AWWA C110 or C115. Provide standard thickness interior cement-mortar lining per AWWA C104. Provide

standard thickness exterior coal tar coating per AWWA C151.

2. Ductile Iron Fittings: Main pipeline fittings (including end caps, ells, tees and crosses) shall be ductile iron, conform to the requirements of AWWA C110 or C153, with a pressure rating of 150 psi or greater, for fittings and C111 for rubber gasket joints, and be compatible with AWWA C900 and C905 PVC pipe. Fittings shall have flanged or mechanical joints, conforming to AWWA C110 or C153 as applicable. Push-on joints are not acceptable. Nuts & bolts shall be ASTM A307, Grade B, conform to AWWA C110, Appendix A, and shall be galvanized as specified in ASTM A153. Gaskets for flanged joints shall be rubber, flat-faced,  $\frac{1}{8}$ " thick, suitable for potable water service and conforming to AWWA C110.
  - a. The interior of ductile iron fittings shall be coated with a cement mortar lining in accordance with AWWA C104. The exterior shall be coated with a petroleum asphaltic (coal tar) coating per AWWA C110 or C153, as applicable.
  - b. The fittings may be fusion bonded epoxy lined and coated per AWWA C116. The use of fusion bonded epoxy fittings requires the addition of two (2) washers for each bolt and nut pair. The washers are to be placed against the epoxy coating in order to distribute the bolt and nut force thereby minimizing epoxy cracking. If cracking does occur, the fitting shall be removed, properly prepared and repaired with Scotchkote 312, or as recommended by the powder epoxy manufacturer.

C. Polyvinyl Chloride Pipe (PVC):

1. Main Pipe: Water mains shall be PVC pressure pipe conforming to AWWA C900, Class 150, SDR18, and AWWA C905, Class 235, SDR18, unless otherwise noted. Where called for, AWWA C900, Class 200, SDR14 shall be installed. PVC pipe shall be made of polyvinyl chloride compound 12454-B per ASTM D1784. PVC main pipe outside diameters shall be cast iron pipe size (IPS). PVC pipe shall be supplied in standard 20 foot lengths. Pipe joints shall be the bell-and-spigot type, self-centering, with O-ring elastomeric gaskets, conforming to ASTM D3139 and F477. The gasket material shall conform to AWWA C-300.
2. Small Diameter Pipe: Miscellaneous small diameter PVC pipe shall conform to ASTM D1785. Schedule of pipe shall be as noted in the Details, and Improvement Plans if any, but not less than Schedule 40.
3. PVC Fittings: PVC fittings shall conform to ASTM D1784, and shall be a minimum of Schedule 40.

D. Polyethylene (PE) Pipe

1. 1" Diameter: PE pipe shall conform to AWWA C901-88, ASTM Designation D2239, PE 3408, SDR 7, and shall have a pressure rating of not less than 200 psi at 23°C. PE pipes up to and including one inch (1") in diameter shall be inside diameter (ID)-based iron pipe size (IPS).
  2. Over 1" Diameter: PE pipe shall conform to ASTM Designation D2737, PE 3408, SDR 9, and shall have a pressure rating of not less than 200 psi at 23°C. PE pipes over one inch (1") in diameter shall be copper tubing size (CTS).
  3. PE pipe shall not be used for pipelines larger than three inches (3") in diameter.
  4. Packaging of polyethylene pipe: The pipe shall be coiled and packaged for protection against dirt and damage during shipment, handling and storage.
- E. Brass Pipe: Where called for, provide seamless red brass pipe suitable for use in potable water service lines and plumbing, conforming to ASTM B43.
- F. Pipe Couplings:
1. Mechanical Joint Adapter: Mechanical joint adapters shall conform to AWWA C111. Adapter bodies and end rings installed underground shall be ductile iron. Adapter bodies and end rings installed above ground may be fusion bonded epoxy-lined and coated steel or ductile iron. Bolts and nuts shall conform to AWWA C111, Appendix B, and shall be galvanized as specified in ASTM Designation A-153. Gaskets shall conform to AWWA C111, be suitable for use with water and shall be suitable for the type of pipe being coupled. Anchor studs or retention rings are not allowed when coupling to PVC pipe.
  2. Flange Coupling Adapter: Flanged coupling adapters shall conform to AWWA C219. Adapter bodies and end rings installed underground shall be ductile iron. Adapter bodies and end rings installed above ground may be fusion bonded epoxy-lined and coated steel or ductile iron. Bolts and nuts shall conform to AWWA C111, Appendix B, and shall be galvanized as specified in ASTM Designation A-153. Gaskets shall conform to AWWA C111, be suitable for use with water and shall be suitable for the type of pipe being coupled. Anchor studs are not allowed when coupling to PVC pipe. As shown on the Drawings, the flanged coupling adapters shall be Smith-Blair Style 912 or 913 or approved equal.
  3. Compression Couplings: Compression couplings (including straight, transition, reducing and end cap types) shall be ductile iron and shall conform to AWWA C219. Gaskets shall be suitable for use with potable water and shall be suitable for the type of pipe being coupled. Bolts and nuts shall conform to AWWA C111, Appendix B.

4. Insulated Flanges and Couplings:
  - a. Insulation Points: Install an approved, electrically-insulating connection at all pipe connections where dissimilar coating or lining materials occur, and at connections to other appurtenances where shown in the Details or Improvement Plans.
  - b. Flange Insulation Kits: shall consist of a central gasket, bolt sleeves, insulated washers and steel washers. The central gasket shall be reinforced. Insulating materials shall have sufficient strength to operate at the pressure rating of the pipe to which they will be coupled, and shall be suitable for direct burial. Flange insulating kits shall be as manufactured by the M&P Flange & Pipe Protection Inc., the PSI Company, or approved equal.
  - c. Insulated Mechanical Couplings: The coupling shall be supplied with insulating boots. Insulating materials shall have sufficient strength to operate at the pressure rating of the pipe to which they will be coupled, and shall be suitable for direct burial. Insulated couplings shall be Romac style IC501, Smith-Blair style 416, or approved equal.
5. Mechanical Couplings: Where shown on the Drawings, the mechanical couplings shall be Smith-Blair 441 series, Romac 501 series, or approved equal, with joint harness assemblies. The pipe stop shall be removed. The thickness of the middle ring (sleeve) shall not be less than the thickness of the adjoining pipe. The middle ring (sleeve) and followers shall be coated with fusion bonded epoxy. The bolts and nuts shall be galvanized as specified in ASTM Designation A-153.

## 2.03 VALVES

- A. General: Sectionalizing valves are those installed in the distribution system excluding those in appurtenances and services. All sectionalizing valves four (4) inches and larger shall be flanged butterfly valves per subsection 2.02.B. All below ground sectionalizing valves smaller than four (4) inches shall be flanged gate valves per subsection 2.02.C. All valves shall have a full-opening flowway equal to the nominal diameter of the connecting pipe. Valve installations shall be complete with all gaskets, bolts and all else required to complete the valve in an operating, watertight condition. Valves shall be furnished with companion flanges. Valves shall have all ferrous interior surfaces epoxy coated in conformance with the provisions of AWWA C550, with Keysite Epoxy No. 740, Scotchkote Epoxy No. 306, or approved equal, suitable for use in potable water. Valves located underground shall have a coal tar coating in accordance with applicable provisions of AWWA C203. All valves located above ground shall be furnished with removable handwheels. All below-ground valves shall be provided with two inch (2") square operating nuts and have two (2) o-ring stem seals. If the operating nut on below-ground valves is deeper than 60", then a

valve nut extension shall be installed. Valves shall open when turned counterclockwise, that is, when turned to the left.

- B. Butterfly Valves: All butterfly valves shall conform to the applicable provisions of AWWA C504, and be flanged (short body), and not of the wafer type. Valves shall be Class 150 pressure rating, show no leakage under 200 psi pressure, and shall be as manufactured by Pratt or approved equal.
- C. Ball Valves: ball valves shall be have bronze bodies with threaded ends, full-ported chrome-plated brass balls, virgin PTFE (Teflon) seats and stem packing, and brass stems with adjustable stem packing nuts threaded into the body. Ball valves shall have a pressure rating the same as or greater than that of the pipeline at the point of installation. Ball valves shall be Watts series FBV-3 or approved equal.
- D. Gate Valves: All gate valves shall have a non-rising stem, shall be bronze mounted, shall have a Class 150 pressure rating, and conform to the applicable provisions of AWWA C500. Below-ground gate valves shall be furnished with cast iron discs and flanged bodies suitable for buried installation, resilient seats, bronze mounts, and 2" square operating nuts. Double disc styles are unacceptable. They shall be as manufactured by American-Darling Company, Mueller Company, M&H, or approved equal. Above-ground gate valves shall have bronze bodies and shall be provided with a removable handwheel.
- E. Check Valves: All check valves shall conform to the applicable provisions of AWWA C508. Check valves shall be iron body, swing type, flanged and bronze fitted, and shall be furnished with an external lever and single weight or spring.. The seating ring of the valve and disc shall be bronze. The valve body and disc so proportioned that they will provide a passage fully equal in area of the nominal pipe size of the valve, when the valve is in the wide-open position. Check valves shall have a pressure rating equivalent to that of the pipeline of which they are to become a part. The valves shall be shop tested to a pressure of 150 psi, and under this test there shall be no leakage in any part of the valve assembly nor shall any part be permanently deformed. Check valves shall be as manufactured by Eddy-Iowa, Bailey, or approved equal.
- E. Air Release & Vacuum Valves (ARV): All air release and vacuum valves for ARV installations shall have the same pressure rating as the pipeline at the point of installation. Above-ground piping, below-ground piping and housing shall be as shown in the Standard Details. Air release and vacuum valves shall be Bermad Model 02-ARC-P.

## 2.04 FIRE HYDRANTS AND APPURTENANCES

- A. Hydrants shall be the wet-barrel type and have two 2½" outlets and one 4½" outlet. All outlets shall have National Standard threads and cast iron caps with bleed ports and chains.

- B. Hydrants shall be supplied with a factory-applied coat of bright white industrial epoxy paint. Hydrant assemblies shall include, break-off bolts, break-off risers, break-off check valves and hub-end hydrant burys.
- C. Break-off bolts and nuts shall be carbon steel with a minimum 60,000 psi tensile strength conforming to ASTM A307, grade A. Bolts shall be standard ANSI B1.1, class 2A coarse threads. Nuts shall conform to ASTM F563 and be standard ANSI B1.1, class 2A coarse threads. All bolt heads and nuts shall be hexagonal. Identification on the head of the bolt shall be A 307 A. 5/8" diameter break-off bolts shall have an 11/32" hole drilled in the shank 2 3/8" deep. 3/4" diameter break-off bolts shall have a 13/32" hole drilled in the shank 2 3/8" deep. The drilled holes shall be filled with 100% silicon sealant to prevent moisture from corroding the bolt internally.
- D. The size and configuration of the various components of the fire hydrant installation shall be as indicated on the Drawings, in the Standard Details, or as specified herein. Pipe and fittings shall be as shown on the Drawings and shall conform to the appropriate sections of these Specifications.
- E. Hydrants shall be Clow Valve Company, Model 960 three-way fire hydrant, or approved equal.

## 2.05 SERVICE LINE FITTINGS

- A. Service Saddles: Saddles shall be sized for use on cast iron pipe size AWWA C900-89 PVC main. Saddle bodies shall be the bronze, stainless steel double-strap type. Saddles shall be provided with female iron pipe thread outlets per AWWA C800-89. Assembly hardware shall be silicon bronze or stainless steel. The gasket shall be of material suitable for use with potable water.
- B. Bronze Fittings and Stops: Bronze tees, ells, reducers, nipples, and stops shall conform to the requirements of AWWA C800-05. All 3/4" and 1" fittings for connecting to IPS PE pipe shall be Mueller "Insta-Tite" adapters. Fittings larger than 1" in size for connecting to CTS PE pipe shall be Ford "Pack Joint", Mueller 110 Compression Connector or approved equal. Corporation stops shall have male iron pipe threads. Angle meter stops shall be bronze and lockable.

## 2.06 WATER METERS

- A. Consistent "Standard" Flow Water Meters: Meters on potable water services shall be bronze, conform to AWWA C700 and be Sensus Model SR-II EB meter. Provide Radio-Read System equipment including a meter transceiver unit (MXU) model 520R Pit Set Unit and box lid-mounted transmitter. Meters are to read in cubic feet, and are to be furnished installed by the District at the Owner's expense.
- B. Variable Flow Water Meters: Meters on non-potable water services shall be bronze, conform to AWWA C700 and be Sensus SRH-EB Compound meter. Provide Radio-Read System equipment including a meter transceiver unit (MXU)

model Sensus 520R Pit Set Unit and box lid-mounted transmitter. Meters are to read in cubic feet, and are to be furnished and installed by the District at the Owner's expense.

## 2.07 BACKFLOW PREVENTION ASSEMBLIES

- A. Only assemblies that have been approved for use by the California Department of Public Health (CDPH) may be used. Only the USC Foundation for Cross Connection Control and Hydraulic Research is recognized and acceptable to CDPH. The District Engineering Department keeps a copy of the list of approved assemblies. The list of approved assemblies may be found at the website noted in the Standard Details. Double detector check assemblies on fire services shall also conform to the requirements of Underwriters Laboratories (UL) and Factory Mutual (FM). The assemblies are to be furnished and installed by the Contractor at the Owner's expense.

## 2.08 SAMPLING STATIONS

- A. Sampling stations shall have a drain tube, an unthreaded nozzle, and an 18" bury. Sampling stations shall be The Kupferle Foundry Company model Eclipse 88WC.

## 2.09 COATINGS, LININGS & PAINT SYSTEMS

- A. Fusion Bonded Epoxy Lining and Coating Systems: Fusion bonded epoxy systems shall conform to AWWA C213. The minimum thickness shall be 20 mils.
- B. Epoxy Lining Systems: Epoxy lining systems shall conform to AWWA D102, Section 3.2, "Inside Paint System No. 1 (Epoxy)." Per AWWA D102-78, the dry film thickness for Inside Paint System No. 1 is 8 mils. The minimum thickness shall conform to latest edition of AWWA D102.
- C. Tape Coating: Tape coatings are unacceptable for above-ground piping. Continuation of below-ground tape coating to a minimum distance above the ground line as specified is acceptable.
  - 1. Field-Applied Tape Coating: Field-applied tape coatings shall conform to AWWA C209. The minimum thickness shall be 30 mils, and the minimum overlap shall be ½ inch.
  - 2. Factory-Applied Tape Coating: Factory-applied tape coatings shall conform to AWWA C214. The minimum tape thickness shall be 50 mils.
- D. Above-Ground Painting:
  - 1. Piping: Above-ground epoxy painting shall conform to AWWA D102, Section 2.1, Outside Paint System No. 1, special color, and shall have a

prime coat of 3.0 mils self-priming epoxy. The finish coat shall be a two-component aliphatic polyurethane of 3 mils. Color shall be as specified herein, in the Standard Details, or in the Improvement Plans, if any. Intermediate paint coats shall be tinted to provide discernable contrast in the subsequent coat.

2. Miscellaneous Metal: Unless otherwise specified herein, in the Standard Details, or in the Improvement Plans, if any, piping and exposed metal called to be painted shall be painted with Devco "Bar-Rust 233H" multi-purpose epoxy coating, buff color (Cat. No. 233H1642), or approved equal.

E. Galvanized Lining and Coating: Galvanized lining and coating shall conform to ASTM A120.

## 2.10 MANIFOLDS

A. Manifolds shall include all piping, butterfly valves, motor operated butterfly valves, check valves, air and vacuum valves, flanges, mechanical couplings, joint harnesses, gauges, taps, cocks, bolts, pipe supports, flanged coupling adapters, insulating kits where required, concrete thrust blocks and encasement, and all other fittings and materials required to complete the manifolds in a watertight, operating conditions.

B. Reinforcement of openings shall conform to Section VIII of the ASME Boiler and Pressure Vessel Code.

C. The Contractor shall furnish and install companion flanges, gaskets, and bolting. Bolts and nuts shall be stainless steel with two stainless steel washers installed one each under the bolt head and nut. The Contractor shall also furnish and install flanges, mechanical couplings and joint harness lugs required to join pump discharges to the manifolds.

## 2.11 MISCELLANEOUS MATERIALS

A. Polyethylene (PE) Film: Polyethylene film for encasing (wrapping) ductile iron fittings, nuts and bolts, and miscellaneous metals shall conform to the requirements of AWWA C105. Minimum film thickness is 20 mils.

B. Pipeline Warning Tape: Warning tape shall be metallic, 12" wide, 4 mil thick polyethylene. Tape shall be colored, and labeled with black lettering as follows:

Tape Color: Blue  
Tape Labeling: CAUTION - WATER LINE BURIED BELOW

C. Hydrant Pavement Markers: Reflective markers used to mark locations of fire hydrants shall conform to the requirements of Section 85, "Pavement Markers," of the State of California, Department of Transportation Standard Specifications.

Color shall be blue.

- D. Reinforcing Bars: Reinforcing steel shall conform to ASTM Designation A615 Grade 40 for deformed and plain billet steel bars for concrete reinforcement.
- E. Concrete: Concrete shall use Portland cement conforming to ASTM C150, Type II, and have a minimum cement content of 5 sacks per cubic yard. Minimum relative compressive strength shall be 3,000 psi after 28 days.
- F. Valve and Meter Boxes:
1. Air Release Valve (ARV) Boxes: provide Christy Fibrelyte model FL-36 or approved equal, with Fibrelyte extensions sufficient to provide required depth. Provide model Placer Waterworks model PW/AE3618-M cover with factory applied epoxy coating, color as directed by the Engineer.
  2. Water Meter Boxes: provide Christy Fibrelyte box or approved equal, with Fibrelyte extensions sufficient to provide required depth. Provide box lid with round opening for Sensus "Radio-Read" box lid-mounted MXU transmitter. See Standard Details for size required.
  3. Water Valve Boxes: Christy Model G-5 utility box with cast iron round traffic cover marked "WATER" as shown in the Standard Details, or approved equal.
  4. Blowoff Boxes: Christy Model G-12 utility box with cast iron traffic cover marked "WATER" as shown in the Standard Details, or approved equal.
- G. Concrete Grade Boxes: On a case-by-case basis, with the approval of the Water and Power Operations Manager and Engineer, concrete boxes, extensions and lids may be substituted for fiber reinforced plastic boxes of the same size. All other requirements shall be the same as those specified for valve and meter boxes in section 2.10.F, above.
- I. Grade Box Blocking: Redwood shall be placed under all grade boxes, available locally. Their size and length shall be as shown in the Standard Details. If not specified, the minimum nominal size shall be two by four (2"x4") with the length to extend two inches (2") beyond each end.
- J. Stainless Steel Nuts and Bolts: As required per the Standard Specifications and Details, Stainless steel nuts and bolts shall conform to ASTM F593 for bolts and ASTM F594 for nuts. Bolts shall be threaded to conform to ANSI B 18.2.1, page C-1 for finished hex bolts. Nuts shall conform to ANSI B 18.2.2, Page D-1. Nuts shall be finished with TRIPAC 2000 or an approved equal fluoropolymer coating system to minimize galling and ensure proper torque. Anti-seize compound shall not be used with the "blue" nuts. All bolt heads and nuts shall be hexagonal. Identification on the head of the bolt shall be T-316, 316, F593G or F593H.

Silicon bronze nuts and bolts shall conform to ASTM F 468. Material shall meet UNS Alloy No. C65100, low silicon bronze B. Bolts shall be standard ANSI B1.1, Class 2A coarse threads. All bolt heads and nuts shall be hexagonal. Washers shall be of the same material as the bolts and nuts. Identification on the head of the bolt shall be 651, SB or unmarked.

### **PART 3 EXECUTION**

#### **3.01 WORKMANSHIP STANDARDS**

- A. The size and configuration of the various components of the water system shall be as indicated herein, in the Standard Details, and in the approved Improvement Plans, if any. The work shall be completed in a workmanlike manner to insure an operable and watertight condition.

#### **3.02 WATER-SEWER SEPARATION REQUIREMENTS**

- A. Installation of water mains adjacent to sanitary sewers shall conform to the State of California Department of Health Services "Water Main Separation", adopted March 3, 2008. See the Standard Details. Provide minimum clearances between water and sewer services to residence or business. Installation of water and sewer laterals in the same trench shall be in accordance with the Uniform Plumbing Code.

#### **3.03 TRENCH EXCAVATION AND BEDDING**

- A. Trench Safety Requirements: the Contractor shall adhere to the Trench Safety Plan outlined in Section 00700.6.10.F.
- B. Refer to Section 02300 – Earthwork, subsection 3.12 – Trenching for Pipe and subsection 3.13 – Backfill of Pipe.

#### **3.04 TRENCHLESS PIPE INSTALLATION**

- A. Pipelines may be installed using trenchless technology. The Contractor shall confirm the location and depth of all utilities to be crossed by pipelines installed using trenchless techniques. Said utilities, if damaged, shall be repaired to the satisfaction of the utility owner at the Contractor's expense, and no additional payment will be allowed for such repairs.

#### **3.05 PIPELINE INSTALLATION**

- A. General: Contractor shall provide all labor, material, and equipment to install all pipe and other appurtenant apparatus required to complete the potable water pipeline in an operating, watertight condition. Contractor shall furnish all supports, bracing, other materials and all work required for hauling, unloading, distributing, trenching, protecting, dewatering, placing, backfilling, disinfecting, cleaning and testing of the pipeline and appurtenances, and for resurfacing of

roads and jobsite cleanup.

B. Handling of Materials: During handling, loading, transportation and unloading, every precaution shall be taken to prevent injury to the pipe, fittings, valves and appurtenances. Coatings, linings and finishes shall be protected from damage. The manufacturer's recommendations for handling materials shall be followed in all details. No pipe shall be dropped or allowed to roll down skids without proper restraining ropes. During transportation, storing and stringing, each joint of pipe shall rest upon suitable pads, strips, or blocks as recommended by the manufacturer and shall be securely wedged into place. Materials shall be carefully lowered into the trench. Any materials damaged beyond repair, in the opinion of the Engineer, shall be replaced by, and at the expense of, the Contractor.

C. Cleanliness and Cleaning During Construction:

1. All materials shall be thoroughly clean before installation. The pipelines must be kept clean and dry during construction. The Contractor shall take precautions to prevent contamination of the interior of pipes, fittings valves and appurtenances by dirt, debris and animals entering the pipe.
2. If dirt, debris or animals have entered into pipe, it/they shall be removed by the Contractor. If the pipeline is for potable water, the interior surfaces shall be swabbed with a 1 percent hypochlorite disinfecting solution by the Contractor. Further cleaning per AWWA C651, Section 4.5 may be required by the Engineer. If the main is flooded during construction, the Contractor shall comply with AWWA C651, Section 4.7. After construction is completed, the main shall be disinfected using the continuous-feed or slug method, per AWWA C651.
3. At the close of each work day and when pipe installation is not in progress, exposed ends of the pipeline shall be protected with approved temporary bulkheads furnished and installed by the Contractor. Temporary bulkheads shall not be removed until the trench is dry. Before work is stopped for the day, all joints shall be completed with the exception of joints adjoining structures.

D. Connections to Existing Mains:

1. Main-line connections shall be made by installing standard flanged ductile iron fittings in the existing mains where shown on the plans. "Hot tap" connections are not permitted except for service connections up to two inches (2") in diameter.
2. The Contractor is to coordinate the sequence and method of connection with the Engineer before making the connection. The sequence and method of connection are subject to the approval of the Engineer.

3. The Contractor shall notify all affected users in writing at least 24 hours in advance of service interruption. The Contractor shall notify the Engineer, at least 48 hours in advance to schedule valve closures for service interruption. Only District crews are to operate existing valves.
4. Disinfection of materials and equipment used for connections to existing potable water mains shall conform to AWWA C651. Newly installed extensions of the water system are to remain isolated from the system in service until bacteria tests on the new extensions are passed. If isolation is provided by a closed valve in the existing system, pressure testing for leakage in the new facilities shall be conducted only after the acceptable bacteriological tests.

E. Pipe Laying:

1. The pipe shall be placed firmly in the center of the trench and true to line and grade with no visible change in alignment at any joint, unless the alignment is shown to be curved in the Improvement Plans. Joint deflection for curved alignments shall not exceed 80% of the manufacturer's recommended values. On slopes greater than ten percent (10%) the pipe bells shall be pointed up-grade and laying shall proceed up-grade.
2. The pipe joints shall be assembled according to the manufacturer's recommendations, these Specifications, and as directed by the Engineer. The use of power equipment such as backhoes or excavators shall be prohibited unless approved by the Engineer. Regardless of the method used the joints shall be watertight. If it is necessary that a pipe be moved or that the alignment be adjusted after it has been installed, it shall be removed and rejointed as was accomplished in the original installation.
3. Except as required for backfilling, the Contractor shall prohibit walking or working upon the pipe until backfilling of the trench has been completed. The Contractor shall provide temporary bridging over pipe trenches where it is necessary to provide crossings for workers and equipment, or access roads.
4. The Contractor shall take all necessary precautions to prevent the pipe from floating due to water entering the trench from any source, shall assume full responsibility for any damage and shall, at his own expense, restore and replace the pipe to its specified condition and grade if it is displaced due to flotation.

F. Pipe Bedding:

1. Comply with subsection 3.13 – Bedding and Backfill of Pipe, of Section 02300 - Excavation.
2. All pipe, specials and fittings shall be bedded in sand. The bedding shall be to the dimensions as shown in the Drawings and Standard Specification Details. The Contractor shall use extreme care in placing the sand under the haunches to assure that all spaces are filled under and about the pipe. The sand bedding shall be compacted to not less than 70% relative density as determined by ASTM D-4253. Jetting of water pipe bedding is not permitted.

G. Steel Pipe:

1. Field Welding Steel Pipe: field welding of pipe joints and attachments shall conform to AWWA C206. If previously coated and/or lined, field welded joints shall be recoated and lined with approved coating and lining systems.
2. Below-Ground Coatings and Encasement: refer to subsection 2.08 for acceptable materials. All buried steel piping, fittings and fabrications shall be coated. Steel pipe and fittings shall be tape wrapped per subsection 2.08.C to a point at least three inches (3") above final grade. Brass pipe and bronze fittings shall be tape wrapped per subsection 2.08.C to one inch (1") above and below the concrete when passing through a concrete pad. An electric holiday detector shall be passed about the entire circumference of tape-coated pipe to locate holidays and pinholes after coating and before installation. Any defective coating shall be repaired and retested. Fittings, piping and miscellaneous steel that will have concrete support pads or thrust blocks cast next to or around them shall polyethylene encased per AWWA C105 using PE film per subsection 2.10.A between the fitting and the concrete but not be encased. Fittings shall be clean of pipe bedding material, soil, etc., prior to PE barrier placement. Below-ground nuts and bolts shall be tape wrapped per subsection 2.08.C. Exposed bolt threads shall be coated with spray-on silicon sealant.
3. Above-Ground Painting: refer to subsection 2.08 for acceptable materials. All above ground piping, fittings, and fabrications shall be painted with industrial primer and epoxy paint unless otherwise noted. Color shall be as specified. Before painting, all piping shall be cleaned and free of mill scale. Paint shall be applied per the manufacturer's recommendations, and shall be checked for holidays and pinholes by an approved method. Brass and stainless steel hardware shall not be painted unless otherwise specified.
4. Linings: refer to subsection 2.08 for acceptable materials. All piping, couplings and fittings three inches (3") and larger shall be lined. All piping, couplings and fittings two and one-half inches (2½") and smaller

shall red brass piping or bronze fittings and require no additional lining unless specified by the Engineer.

5. Manifolds: All manifolds and piping shall be lined and coated with fusion-bonded epoxy as shown on the drawings. All exposed piping, fittings, and valves shall be painted after the field installation and testing have been completed. All piping shall be cleaned and free of mill scale. All exposed exterior surfaces shall be painted in accordance with AWWA D-102, Section 2.2 Outside Paint System No. 1, special color, and shall have one priming epoxy coat of 3.0 mils. The finish coat shall be a two-component aliphatic polyurethane of 3 .0 mils. The lining, coating and exterior painting shall be applied per the manufacturer's recommendations and checked for holidays and pinholes by an approved method.

#### H. PVC Main Pipelines:

1. Elastomeric gaskets for PVC joints, supplied loose, shall be stored in a cool, well-ventilated place, and shall not be exposed to the direct rays of the sun, until immediately before joint assembly.
2. The joints shall be lubricated and assembled in accordance with the manufacturer's recommendations. There shall be no pulling of joints unless shown in the plans or approved by the Engineer, and shall comply with the manufacturer's recommendations.
3. Care shall be taken in fitting the pipe together to avoid twisting or otherwise displacing or damaging the gasket. After the joint has been assembled, the position of the gasket shall be verified by passing a feeler gauge around the complete circumference of the joint. If the gasket is "fish-mouthed" or otherwise displaced, the joint shall be disassembled, a new gasket installed, the pipe relaid, and the position of the gasket rechecked.
4. There shall be no service or appurtenance connections within two (2) feet of a pipe joint, minimum, or as directed by the Engineer.
5. No rubber-gasket joint shall be encased in concrete.

#### I. Main Fittings & Valves:

1. Fittings shall be supported independently of the pipe. Temporary supports under fittings or under pipe adjoining fittings will not be permitted. Permanent supports under fittings may be redwood blocks or concrete foundations approved by the Engineer.
  - a. Temporary supports may be used during the curing period of concrete foundations. The supports must be constructed to either

become an integral part of the foundation or outside of the required foundation area, as directed and approved by the Engineer.

2. Preassembling flanged fittings, steel fittings and adjoining pipe, before installation in the trench will be permitted. The bolting shall be drawn up evenly around the periphery of the flange so as to ensure even pressures and required torque on the gasket before lowering into the trench and connecting to the pipeline. The contractor, at no additional expense, shall provide adequate labor force, equipment and harnessing required to install the preassembled facilities in a safe and efficient manner or as directed by the Engineer.
3. Fittings shall be polyethylene encased per AWWA C105 using PE film. No joint shall be encased in concrete. If necessary the Contractor shall use long or special fittings to comply with this requirement. Fittings shall be clean of pipe bedding material, soil, etc., prior to PE encasement. Ends of the PE film shall be taped closed around the covered materials.
4. Valves shall be set plumb with operating nuts installed on the side of the valve closest to the curb. Provide a valve box at each valve per the Standard Details.

### 3.06 THRUST BLOCKS

- A. Concrete thrust blocks are required at all angle points, tees, terminal points of the line, and fire hydrant connections. Thrust block configurations shall be of the configuration indicated on the drawings or the Standard Specification Details. Thrust blocks shall not cover joints. If necessary the Contractor shall use long or special fittings to comply with this requirement.
- B. Thrust blocks will be unreinforced concrete placed against undisturbed earth as shown in the Standard Details. When the site has been over excavated, thrust blocks may be cast against backfill approved by the Engineer which is mechanically compacted to ninety-five percent (95%) relative compaction. The compaction shall be verified by an outside agency and the results submitted to the Engineer for approval.
- C. The thrust blocks shall be centered about the center line of the joint and the pipe, shall have a minimum dimension parallel to the pipe centerline of one foot (1'), shall be equal in width to the pipe trench, and extend to six inches (6") below the bottom and above the top of the pipe.
- D. Concrete thrust blocks shall be cured one (1) day before the pipeline may be filled with water and three (3) days before the pipeline may be pressurized.

### 3.07 TRENCH BACKFILL

- A. Warning Tape: Warning tape shall be placed in the same trench, directly over and

not more than 12" above all main pipelines.

- B. Tracer Wire: As directed by the Engineer, tracer wire shall comply with Section 02519 – Conductive Trace Wire for Nonmetallic Pipe Installation.
  
- B. Backfilling and Compaction: Comply with Section 02300 – Earthwork. Compaction of the backfill material shall be as shown in the Standard Details. The Contractor shall use extreme care in compacting the backfill in the vicinity of the pipe to avoid damaging the pipeline. Jetting of trench backfill is not permitted.

### 3.08 TRENCH RESURFACING

- A. Comply with Section 02740 – Asphaltic Concrete Paving and the Standard Details.

### 3.09 APPURTENANCE INSTALLATION

- A. Reduced Pressure Backflow Prevention Assemblies: all assemblies shall be tested immediately after they are installed. Testing shall be done by the District, and Contractor shall give 24 hours advanced notice of readiness for testing. Backflow preventers shall be installed per the Standard Details.
  
- B. Fire Hydrants: the Contractor shall provide all labor, materials, fittings, valves, appurtenant apparatus, and equipment to complete the installation in a workmanlike manner to ensure an operable and watertight condition. Hydrant break-off spools shall be installed with break-away bolts on the upper flange of the break-off spool with the nuts facing up. Hydrants and above-ground piping shall be painted per subsection 2.08.D.1, above. Refer to the Standard Details.
  
- D. Air Release & Vacuum Valve and Blowoff Installation: Install ARVs and blowoffs where shown in the Improvement Plans, per Standard Details. Final location shall be determined in the field by the District Inspector. ARV and blowoff installations shall include connection of the installation to the pipeline including reinforcement if required, bronze ball valves, piping, PVC pipe wells with lids (for below-ground installations of ARVs and blowoffs), and all else required to complete the installation in an operating, watertight condition.
  
- E. Service Connections: Install service connections as shown in the Standard Details at the locations shown in the Improvement Plans. The minimum service pipe size is one inch (1"). Trenches for service pipes shall be excavated, backfilled and resurfaced per these Standard Specifications. Trenchless installation is preferred under existing paved surfaces, and may be used in any location. PE pipe shall be installed in accordance with applicable provisions of AWWA C901. Adjacent taps into the water main shall be separated by at least one foot (1') and connections shall not be closer than two feet (2') from pipe joints or as directed by the Engineer or the end of the main pipe. Backflow preventers, if required, must be installed, tested and accepted prior to the delivery of water to

the site.

- F. Sampling Stations: Locate sampling stations where shown in the Improvement Plans or as directed by the Engineer.
- G. Guard Posts: The Contractor shall provide all labor, materials and equipment required to furnish and install the guard post installations as indicated on the drawings and the Standard Details.

### 3.10 FILLING PIPELINES

- A. Connections between new and existing pipelines shall be isolated with a control valve and double check valves. The rate of filling the new pipeline shall be limited to 500 gpm to avoid stirring sediments in the existing distribution system. Control valves shall be opened and closed slowly to minimize pressure surges in the pressurized existing pipelines. Forty eight (48) hours advanced notice will be given by the Contractor to the Engineer, which will notify the District Operations Department of the planned filling.

### 3.11 DISINFECTION

- A. Chlorination and Flushing: Disinfection shall be in accordance with AWWA C-651 - Disinfecting Water Mains, by use of the tablet method, unless the pipe was flooded during construction. (See subsection 3.05.C.2.) The required number of 5-g calcium hypochlorite tablets shall be placed in each section of pipe during construction. One such tablet shall be placed in each hydrant, hydrant branch and other appurtenance. The tablets shall be attached by a food-grade adhesive to the top inside of the section of pipe. The required numbers of tablets are as follows:

**Required Number of Hypochlorite Tablets in Each Section of Pipe**

Pipe Diameter	Length of Pipe Section				
	13' or less	18'	20'	30'	40'
4"	1	1	1	1	1
6"	1	1	1	2	2
8"	1	2	2	3	4
10"	2	3	3	4	5
12"	3	4	4	6	7

After a retention period of not less than 24 hours after filling, the line may be flushed by means of the fire hydrants, temporary and permanent blowoffs, services and other locations where water may be discharged through approved de-chlorinating devices or methods see Subsection 3.12. The water shall be released at a rate of at least 2.5 feet per second, but that will not cause erosion of the right-of-way or damage to vegetation at the point of release. Flushing shall be repeated until the chlorine concentration in the water system is less than one (1) milligram per liter (mg/l).

- B. Bacteriological Tests: After final flushing and before the water main is placed into service, water samples will be collected and tested per AWWA C651 by District personnel at the Contractor's expense. Certified results shall be submitted to the Engineer for approval before placing the new water main into service.
- C. Redisinfection: Should the laboratory test results indicate a presence bacteria, virus or other organisms, the disinfection procedure shall be repeated.

### 3.12 DECHLORINATION

- A. Regardless of the measures specified and the actions taken by the Contractor, the Contractor shall be responsible for any penalties and/or fines associated with discharging flushing water containing chlorine.
- B. The Contractor shall submit a written dechlorination and flushing procedure to the Engineer for approval prior to flushing of the pipelines. Any required city or County permits shall be submitted with the procedure.
- C. Vita-D-Chlor dechlorination tablets shall be used or approved equal. Sulfur-based neutralizing agents are unacceptable. The recommended number of pounds of Vita-D-Chlor is as follows:

$$\frac{D^2PL}{1,112,300} = \text{Pounds of Vita-D-Chlor}$$

D = Diameter of pipe in inches  
 P = Parts per million of chlorine  
 L = Length of pipeline in feet

- D. Blowoff Flushing: A suitable length hose will be connected to the blowoff valve and directed to the concrete curb and gutter leading to the storm drain inlet or directly into a storm drain manhole. A mesh bag containing the dechlorination tablets will be placed directly in the flow of flushing water. The water will be frequently tested by the Construction Observer/Inspector or Engineer to insure 0.0 mg/L chlorine water entering the storm drain system.
- E. Hydrant Flushing: An approved hydrant flushing diffuser containing a mesh bag with dechlorination tablets will be connected to a fire hydrant and directed to a storm drain inlet. The water will be frequently tested by the Construction Observer/Inspector or Engineer to insure 0.0 mg/L chlorine water entering the storm drain system.
- F. When a storm drain inlet or manhole is inaccessible, an approved detention basin will be constructed to receive the flushed water. The detention basin shall have a minimum of eighteen inches (18") of freeboard. The basin will contain the flushed water until it has completely percolated into the soil or evaporated.

### 3.13 FIELD HYDROSTATIC TESTING

- A. In addition to any tests required by AWWA, ASTM and any other standard

Specifications referred to in these Specifications, and in addition to any specified shop or plant hydrostatic tests for pipe, a field hydrostatic test shall be required for all pipelines and appurtenances. The Contractor shall provide all labor, equipment, materials, bulkheads and recently-calibrated measuring apparatus required to make the test. The District shall not be responsible for any damage, including damage to the pipeline or appurtenances, due to testing.

B. Preparation for Testing:

1. Prior to the start of testing, the Contractor shall submit the proposed testing procedure, in writing, to the Engineer for review.
2. By necessity, installation of all valves, fittings, appurtenances, concrete thrust blocks and backfill shall be completed so that testing may be undertaken. Trench backfill and compaction shall be completed prior to testing.
3. Temporary bulkheads furnished and installed by the Contractor may be used when approved. After completion of the test, the Contractor shall remove said bulkheads. The Contractor may test against closed sectionalizing valves.
4. The pipeline to be tested shall be slowly filled with water and left under normal operating pressure for at least 24 hours prior to the start of testing. Air shall be expelled from and through all services, blowoffs and hydrants as well as ARVs.
5. Chlorination levels in the pipeline to be tested shall be confirmed before pressure testing any new section of main connected to an existing main.
6. The Contractor may fill the pipeline to check for leaks before backfilling the trench, but must repair any resulting damage or displacement to the pipeline. Said pipeline filling before trench backfilling will not satisfy the hydrostatic testing requirement.
7. Testing shall be done as soon as possible after the completion of the pipeline, but in no event sooner than three (3) days after the placement of any concrete thrust block that will be subject to hydrostatic pressure during a test.

C. Test Sections: Pipelines may be tested in one length, between valves, or between bulkheads, as approved. All appurtenances and service lines shall be considered as part of the main pipeline for the purpose of hydrostatic testing. All exposed pipe, appurtenances and services shall be examined during the pressure test.

D. Test Pressure: Test pressure shall be 150 pounds per square inch measured at the low point in the test section, unless otherwise noted.

- E. Test Duration: The test shall continue for twenty four (24) hours, after which time the amount of leakage and pressure loss shall be observed by the Engineer or Inspector.
- F. Allowable Leakage: Makeup water to replace leakage will be accurately metered as it is added to the pipeline. Under the specified test conditions, the maximum leakage shall not exceed the following amounts, or as outlined in AWWA C-605:
  - 1. PVC Distribution Pipe: ten (10) gallons per day, per inch of pipeline diameter, per mile of pipe.
  - 2. Steel Pipe with Welded Joints: no leakage.
- G. Acceptance and Repair of Pipelines: Regardless of the actual leakage from the pipe, the Contractor shall repair all visible leaks. Cracked or defective pipe, fittings, valves, and appurtenances shall be replaced. Contractor shall continue testing and repair of leaks until the actual leakage is reduced to or below the allowable leakage for 24 hours. If leakage persists after repair, fittings, valves, appurtenances, the pipe joint, joints, or entire pipeline shall be removed and replaced with new material and retested. Leaks shall be repaired by and at the expense of the Contractor.

#### 3.14 BACKFLOW PREVENTER ASSEMBLY TESTING

- A. All backflow preventers (RPBPs and DCDA's) shall be tested by the District prior to activation and acceptance.

#### 3.15 SERVICE AND PIPELINE ABANDONMENT

- A. Existing services and pipelines that will no longer be used shall be disconnected from the main pipeline.
- B. Valves shall be removed from the main pipeline fitting. Flanged fittings shall be properly sealed with a fusion bonded epoxy blind flange. Compression fittings require concrete thrust blocks to properly restrain the fittings.
- C. Corporation stops shall be removed and the service saddle or threaded tap capped as appropriate. At the discretion of the Engineer, the Contractor may be required to remove the service saddle and install an approved full-circle stainless steel repair band or other means of properly plugging the service.
- D. Pipes of materials other than asbestos cement pipe, see below, may be abandoned in place. City standards may require complete removal of abandoned pipes.
- E. Pipelines 4" and larger must be plugged with concrete before backfilling.
- F. Asbestos cement pipe (ACP) service/lateral pipes must be removed. ACP pipe shall be removed and disposed of by certified personnel and methods as set by the

Asbestos National Emission Standard for Hazardous Air Pollutants (Asbestos NESHAP) outlined in 40 CFR Part 61 Subpart M.

1. Proof of certification and evidence of proper disposal must be submitted to the Engineer.
  
- G. All meter boxes, valve boxes and valve wells must be removed and the excavation backfilled per these Standards.
  
- H. Prior to the removal of meter boxes and services, the District must receive forty-eight (48) hour notice in order to remove the meters.

/// END OF SECTION

## SECTION 02517

### HIGH DENSITY POLYETHYLENE (HDPE) PIPE AND FITTINGS 4 INCH DIAMETER AND GREATER

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. This specification includes but is not limited to high-density polyethylene (PE 3408) (ductile iron pipe size O.D) pressure pipe and fittings primarily intended for the transportation of buried water pipelines.
- B. The size and configuration of the various components of the water system shall as indicated herein, in the Standard Details, and in the approved Improvement Plans, if any.
- C. All materials and installation of the system shall be in accordance with the standards and specifications of Solano Irrigation District, latest revision.

##### 1.02 RELATED SECTIONS

- A. Section 01100 – General Requirements
- B. Section 02246 – Horizontal Directional Drilling
- C. Section 02514 – Gravity Irrigation Pipelines (PVC)
- D. Section 02515 – Pressurized Non-Potable Water Systems
- E. Section 02516 – Domestic Water Systems

##### 1.03 REFERENCES

<u>Reference:</u>	<u>Title:</u>
AWWA C906	Polyethylene (PE) pressure Pipe & Fittings, 4 inch through 63 inch for water
ASTM D3035	Standard Spec for PE Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D3261	Butt Heat Fusion PE Fittings or PE Pipe and Tubing
ASTM D3350	Standard Specification for PE Pipe and Fittings Materials
ASTM D1238	Melt Flow Index
ASTM D1505	Density of Plastics
ASTM D2837	Hydrostatic Design Basis
NSF Std.#14	Plastic Piping Components & Related Materials
TR-33/2005	Generic Butt Fusion Joining Procedure for Field Joining of PE Pipe

## 1.04 GENERAL

- A. Use: High Density Polyethylene (HDPE) pipes/fittings will be allowed for use as potable water, pressurized non-potable irrigation water and gravity irrigation water pipe where compatible with the specific conditions of the project. The use of material other than HDPE pipe may be required by the Engineer if it is determined that HDPE pipe is unsuitable for the particular application. All material used in the production of water main piping shall be approved by the Engineer.
- B. Documentation: Documentation from the resin's manufacturer showing results of the following tests for resin identification:
1. Melt Flow Index ASTM D1238
  2. Density ASTM D1505
- C. Manufacturer: All HDPE pipe and fittings shall be from a single manufacturer, who is fully experienced, reputable and qualified in the manufacture of the HDPE pipe to be furnished. The pipe shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with these Specifications. Proposed manufacturers shall be submitted to the Engineer for approval.
- D. Finished Product Evaluation: Production staff shall check each length of pipe produced for the items listed below. The results of all measurements shall be recorded on production sheets, which become part of the manufacturer's permanent records.
1. Pipe in process shall be checked visually, inside and out for cosmetic defects (grooves, pits, hollows, etc.).
  2. Pipe outside diameter shall be measured using a suitable periphery tape to ensure conformance with ASTM F714 or ASTM D3035, whichever is applicable.
  3. Pipe wall thickness shall be measured at 12 equally spaced locations around the circumference at both ends of the pipe to ensure conformance with ASTM F714 or ASTM D3035, whichever is applicable.
  4. Pipe length shall be measured.
  5. Pipe marking shall be examined and checked for accuracy.
  6. Pipe ends shall be checked to ensure they are cut square and clean.
  7. Subject inside surface to a "reverse bend test" to ensure the pipe is free of oxidation (brittleness).

- E. Stress Regression Testing: The polyethylene pipe manufacturer shall provide certification that stress regression testing has been performed on the specific polyethylene resin being utilized in the manufacture of this product. This stress regression testing shall have been done in accordance with ASTM D2837 and the manufacturer shall provide a product supplying a minimum Hydrostatic Design Basis (HDB) of 1,600 psi as determined in accordance with ASTM D2837.
- F. Compatibility: Contractor is responsible for compatibility between pipe materials, fittings and appurtenances.
- G. Warranty: The pipe manufacturer shall provide a warranty against manufacturing defects of material and workmanship for a period of ten years after the final acceptance of the project by the District. The manufacturer shall replace at no expense to the District any defective pipe/fitting material including labor within the warranty period.

#### 1.05 MEASUREMENT AND PAYMENT

- A. Pipelines shall be paid for at the unit price per foot bid therein the Bid Schedule. Payment for main pipelines shall include pipe, fittings, specials, bends, tees, connections, magnetic warning tape, tracer wire, potholing, trenching, over-excavating, placing, boring, dewatering, shoring, bracing, bedding, concrete thrust blocks, backfill, compaction, testing, permits, inspection, cleanup, guaranty, maintenance and all other labor and materials required to construct the pipelines.

### **PART 2 MATERIALS**

The specifications given herein are for pipe and fitting sizes 4 inch (4") diameter and larger. For HDPE service pipe, see the requirements given in the appropriate Section(s) of the Standard Specifications.

#### 2.01 Pipe Sizes 4-Inch Diameter and Larger

- A. Materials used for the manufacture of polyethylene pipe and fittings shall be made from a PE 3408 high density polyethylene resin compound meeting cell classification 345434C per ASTM D3350; and meeting Type III, Class C, Category 5, Grade P34 per ASTM D1238.
- B. High Density Polyethylene (HDPE) pipe shall comply with AWWA Specifications C906.
- C. If rework compounds are required, only those generated in the Manufacturer's own plant from resin compounds of the same class and type from the same raw material supplier shall be used.
- D. Dimensions and workmanship shall be as specified by ASTM F714. HDPE fittings and transitions shall meet ASTM D3261. HDPE pipe shall have a

minimum density of 0.955 grams per cubic centimeter. All HDPE pipe and fittings shall have a Hydrostatic Design Basis (HDB) of 1,600 psi.

- E. HDPE pipe and accessories 4-inch diameter and larger, shall be 160 psi at 73.4° F meeting the requirements of Standard Dimension Ratio (SDR) 17 as MINIMUM STRENGTH.
- F. The pipe Manufacturer must certify compliance with the above requirements.

#### 2.02 Fitting Sizes 4-Inch Diameter and Larger

- A. All molded fittings and fabricated fittings shall be fully pressure rated to match the pipe SDR pressure rating to which they are made. All fittings shall be molded or fabricated by the manufacturer. No Contractor fabricated fittings shall be used unless approved by the Engineer.
- B. The manufacturer of the HDPE pipe shall supply all HDPE fittings and accessories as well as any adapters and/or specials required to perform the work as shown on the Drawings and specified herein.
- C. All fittings shall be installed using butt-fused fittings, thermo-fused fittings or couplings, or flanged adapters and must be approved by the Engineer. **NO** size-on-size wet taps shall be permitted.
- D. All transition from HDPE pipe to ductile iron or PVC shall be made per the approval of the Engineer and per the HDPE pipe manufacturer's recommendations and specifications. A molded flange connector adapter within a carbon steel back-up ring assembly shall be used for pipe type transitions. Ductile iron back-up rings shall mate with cast iron flanges per ANSI B16.1. A 316 stainless steel back-up ring shall mate with a 316 stainless steel flange per ANSI B16.1.
  - 1. Transition from HDPE to ductile iron fittings and valves shall be approved by the Engineer before installation.
  - 2. No solid sleeves shall be allowed between such material transitions.
  - 3. Fittings and transitions shall be as manufactured by Phillips DRISCOPIPE, Inc., 1000 Series Pressure Pipe, Chevron Chemical Company Plexco/Spiralite pipe, or approved equal.
  - 4. The pipe supplier must certify compliance with the above requirements.

#### 2.03 Pipe Identification

- A. The following shall be continuously indent printed on the pipe or spaced at intervals not exceeding 5-feet:

1. Name and/or trademark of the pipe manufacturer.
2. Nominal pipe size.
3. Dimension ratio.
4. The letters PE followed by the polyethylene grade in accordance with ASTM.
5. D1248 followed by the hydrostatic design basis in 160's of psi, e.g., PE 3408.
6. Manufacturing standard reference, e.g., ASTM F714 or D-3035, as required.
7. A production code from which the date and place of manufacture can be determined.
8. Color Identification, either stripped by co-extruding longitudinal identifiable color markings or shall be solid in color and as follows:
  - a. BLUE – Potable Water
  - b. LAVENDER – Non-Potable or Raw Water

**B. Tracing Wire**

1. Open cut trench installation of HDPE shall be identified in the Drawings and may require tracing wire as specified in Section 02519 of the Standard Specifications.
  - a. Open cut trench installation of HDPE shall also require the installation of metallic warning tape.
2. Directional Drilled HDPE shall have wire conforming to Copperhead Industries Reinforced #1245 Extra-High Strength Tracer Wire and affixed to the drilling head/reamer, refer to Section 02519.

## **PART 3 EXECUTION**

### **3.01 JOINING METHOD**

- A. The pipe shall be joined with butt, heat fusion joints as outlined in ASTM D2657 and conform to the Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe, Technical Report TR-33/2005, published by the Plastic Pipe Institute (PPI). All joints shall be made in strict compliance with the manufacturer's recommendations. A factory qualified joining technician as designated by pipe manufacturer or experienced, trained technician shall perform all heat fusion joints in the presence of the District's Construction

Observer/Inspector.

- B. Lengths of pipe shall be assembled into suitable installation lengths by the butt-fusion process. All pipes so joined shall be made from the same class and type of raw material made by the same raw material supplier. Pipe shall be furnished in standard laying lengths not to exceed 50 feet and no shorter than 20 feet.
- C. On days butt fusions are to be made, the first fusion shall be a trial fusion in the presence of the District's Construction Observer/Inspector. The following shall apply:
1. Heating plate surfaces shall be inspected for cuts and scrapes and shall be free of dirt and residue. Heater surfaces should be between 400°F (minimum) to 450°F (maximum). Measure the temperature @ 12:00, 3:00, 6:00 and 9:00 o'clock positions using a pyrometer or infrared thermometer at locations where the heating plate will contact the pipe/fitting ends. The maximum temperature difference between any two points on a single heating surface must not exceed 24°F. If this temperature is exceeded, the heating plate shall be cleaned per the manufacturer's recommendations and retested as stated above.
  2. The fusion or test section shall be cut out after cooling completely for inspection.
  3. The test section shall be 12" or 30 times (minimum) the wall thickness in length and 1" or 1.5 times the wall thickness in width (minimum).
  4. The joint shall be visually inspected as to continuity of "beads" from the melted material, and for assurance of "cold joint" prevention (i.e. – joint shall have visible molded material between walls of pipe). Joint spacing between the walls of the two ends shall be a minimum of 1/16" to a maximum 3/16".
- D. The polyethylene flange adapters at pipe material transitions shall be backed up by stainless steel flanges conforming to ANSI B16.1 and shaped as necessary to suit the outside dimensions of the pipe. The flange adapter assemblies shall be connected with corrosion resisting bolts and nuts of Type 316 Stainless Steel as specified in ASTM A726 and ASTM A307. All bolts shall be tightened to the manufacturer's specified torques. Bolts shall be tightened alternatively and evenly. After installation, apply a bitumastic coating to bolts and nuts.

### 3.02 INSTALLATION

- A. High Density Polyethylene (HDPE) Pipe shall be installed in accordance with the instruction of the manufacturer, as shown on the Drawings and as specified herein. A factory qualified joining technician as designated by the pipe manufacturer shall perform all heat fusion joints.

- B. HDPE shall be installed either by Open Trench Construction per the appropriate Section in the Standard Specifications or Directional Bore Method as outlined in Section 02446 of the Standard Specifications.
- C. Care shall be taken in loading, transporting and unloading to prevent damage to the pipe. Pipe or fitting shall not be dropped. All pipe or fitting shall be examined before installation, and no piece shall be installed which is found to be defective. Any damage to the pipe shall be repaired as directed by the Engineer. If any defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner by the Contractor, at his own expense.
- D. Under no circumstances shall the pipe or accessories be dropped into the trench or forced through a directional bore upon “pull-back”.
- E. Care shall be taken during transportation of the pipe such that it will not be cut, kinked or otherwise damaged.
- F. Ropes, fabric or rubber protected slings and straps shall be used when handling pipes. Chains, cables or hooks inserted into the pipe ends shall not be used. Two slings spread apart shall be used for lifting each length of pipe.
- G. Pipes shall be stored on level ground, preferably turf or sand, free of sharp objects, which could damage the pipe. Stacking of the polyethylene pipe shall be limited to a height that will not cause excessive deformation of the bottom layers of pipes under anticipated temperature conditions. Where necessary due to ground conditions, the pipe shall be stored on wooden sleepers, spaced suitably and of such width as not to allow deformation of the pipe at the point of contact with the sleeper or between supports.
- H. Pipe shall be stored on clean level ground to prevent undue scratching or gouging. The handling of the pipe shall be in such a manner that the pipe is not damaged by dragging it over sharp and cutting objects. The maximum allowable depth of cuts, scratches or gouges on the exterior of the pipe is 5 percent of wall thickness. The interior pipe surface shall be free of cuts, gouges or scratches.
- I. Sections of pipe with cuts, scratches or gouges exceeding 5 percent of the pipe wall thickness shall be removed completely and the ends of the pipeline rejoined.
- J. Pipe shall be laid to lines and grade shown on the Drawings with bedding and backfill as shown on the Drawings or Standard Details.
- K. When laying is not in progress, including lunchtime, the open ends of the pipe shall be closed by fabricated plugs, or by other approved means.
- L. The pipe shall be joined by the method of thermal butt fusion, as outlined in PART 3 – Execution, Section 3.01 Joining Method. All joints shall be made in strict compliance with the manufacturer’s recommendations.

- M. Mechanical connections of the polyethylene pipe to auxiliary equipment such as valves, pumps and tanks shall be through flanged connections which shall consist of the following:
1. A polyethylene flange shall be thermally butt-fused to the stub end of the pipe.
  2. A 316 stainless steel back up ring shall mate with a 316 stainless steel flange.
  3. 316 stainless steel bolts and nuts shall be used.
- N. Flange connections shall be provided with a full-face neoprene gasket.
- O. All HDPE pipe must be at the temperature of the surrounding soil at the time of backfilling and compaction.
- P. If a defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional cost to the District. All pipe and fittings shall be thoroughly cleaned before installation, shall be kept clean until they are used in the work and when laid, shall conform to the lines and grades required.
- Q. Open Trench Installation:
1. The appropriate Standard Specification listed in the Subsection 1.02 Related Sections shall also apply.
  2. The centerline of the pipe shall not deviate from a straight line drawn between the centers of the openings at the ends of the pipe by more than 1/16-in per foot of length. If a piece of pipe fails to meet this requirement check for straightness, it shall be rejected and removed from the site. Laying instructions of the manufacturer shall be explicitly followed.
  3. Good alignment shall be preserved during installation. Deflection of the pipe shall occur only at those places indicated in the Drawings and as approved by the Engineer. Fittings, in addition to those shown on the Drawings, shall be used only if necessary or required by the Engineer.
  4. Each length of the pipe shall have the assembly mark aligned with the pipe previously laid and held securely until enough backfill has been placed to hold the pipe in place. Joints shall not be “pulled” or “cramped”.
  5. Precautions shall be taken to prevent flotation of the pipe in the trench.
  6. When moveable trench bracing such as trench boxes, moveable sheeting, shoring or plates are used to support the sides of the trench, care shall be

taken in placing and moving the boxes or supporting bracing to prevent movement of the pipe, or disturbance of the pipe bedding and the backfill. As trench boxes, moveable sheeting, shoring or plates are moved, pipe bedding shall be placed to fill any voids created and the backfill shall be recompacted to provide uniform side support for the pipe.

7. Restrained joints shall be installed where shown on the Drawings or as directed by the Engineer.

R. Directional Bore Installation:

1. Refer to Standard Specification 02446 - Horizontal Directional Drilling in its entirety.

### 3.03 CLEANING

- A. At the conclusion of the work, thoroughly clean all of the new pipe lines to remove all dirt, stones, pieces of wood or other material which may have entered during the construction period by forcing a cleaning swab through all mains 4" or greater. Flushing velocities shall be a minimum of 2.5 feet per second. All flushing shall be coordinated with the District's Construction Observer/Inspector and District Operations Department. Debris cleaned from the lines shall be removed from the job site by the Contractor.

### 3.04 TESTING

- A. The Contractor must submit his plan for testing to the Engineer for review at least 10 days before starting the test and shall notify District's Construction Observer/Inspector a minimum of 48 hours prior to test.
- B. Above ground testing is inherently risky, it shall be the responsibility of the Contractor to ensure that appropriate safety precautions are observed during the hydrostatic testing.
- C. Pressure testing shall be conducted per manufacturer's recommendations and as directed by the Engineer.
- D. All HDPE potable water mains shall be disinfected and dechlorinated prior to pressure testing as per Standard Specification, Section 02516, Part 3 - Execution, 3.11 – Disinfection and 3.12 - Dechlorination.
- E. All HDPE mains shall be field-tested. Contractor shall supply all labor, equipment, material, recently-calibrated gages, pumps, meters and incidentals required for testing. Each main shall be pressure tested upon completion of the pipe laying, concrete thrust block placement and backfilling operations, including placement of any required temporary roadway surfacing.
- F. Pipelines may be tested in one length, between valves, or between bulkheads, as

approved. All appurtenances and service lines shall be considered as part of the main pipeline for the purpose of hydrostatic testing. All exposed pipe, appurtenances and services shall be examined during the pressure test.

- G. By necessity, installation of all valves, fittings, appurtenances, concrete thrust blocks and backfill shall be completed so that testing may be undertaken.
- H. Testing shall be done as soon as possible after the completion of the pipeline, but in no event sooner than three (3) days after the placement of any concrete thrust block that will be subject to hydrostatic pressure during a test.
- I. All mains shall be tested at 150 percent of the operating design pressure of the pipe unless otherwise directed and approved by the Engineer.
- J. Pressure testing procedure shall be per Manufacturer's recommendations or as follows:
  - 1. Air testing of the pipeline shall not be allowed.
  - 2. Fill line slowly with water. Maintain flow velocity less than 2 feet per second.
  - 3. Expel air completely from the line during filling and again before applying test pressure. Air shall be expelled by means of taps at points of highest elevation.
  - 4. Apply initial test pressure and allow to stand without makeup pressure for two to three hours, to allow for diametric expansion or pipe stretching to stabilize.
  - 5. After this equilibrium period, apply the specified test pressure and turn the pump off. The final test pressure shall be held for 3 hours.
  - 6. Upon completion of the test, the pressure shall be bled off from a location other than the point where the pressure is monitored. The pressure drop shall be witnessed by the Contractor representative and District representative at the point where the pressure is being monitored and shall show on the recorded pressure read-out submitted to the Engineer.
  - 7. Under no circumstance shall the total time under test exceed 8 hours at 150% of the system pressure rating. If the test is not complete, including the actual testing period, within this time limit (due to leakage, equipment failure, etc.), the test section shall be permitted to "relax" for a minimum of 8 hours prior to the next test sequence.
- K. Allowable amount of makeup water for expansion during the pressure test shall conform to Chart 6, Allowance for Expansion Under Test Pressure, Technical Report TR 31/9-79, published by the Plastic Pipe Institute (PPI). If there are no

visual leaks or significant pressure drops during the final test period, the installed pipe passes the test.

- L. If any test of pipe laid disclosed leakage significant pressure drop greater than the manufacturer's recommended loss, the Contractor shall, at his/her own expense, locate and repair the cause of leakage and retest the line. The amount of leakage, which will be permitted, shall be in accordance with AWWA C600 Standards or as directed by the Engineer.
- M. All visible leaks are to be repaired regardless of the amount of leakage.

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## SECTION 02518

### IRRIGATION PIPELINE LINING (CURED-IN-PLACE PIPE)

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Irrigation pipeline lining, as herein specified, consists of installing pipe liner by trenchless methods at the locations indicated in the Drawings. The Contractor shall provide all labor, material and equipment necessary to install the pipe liner, specials and appurtenant apparatus required to complete the pipeline installation in an operating, watertight condition. The Contractor shall also furnish all supports, bracing and other materials and all work required for hauling, unloading, protecting, dewatering, placing, and cleanup of the irrigation pipeline liner installation.
- B. The Contractor is hereby notified that the District's agricultural irrigation distribution pipelines are pressure pipelines, unlike gravity storm drain pipelines, and are therefore constructed to tighter standards than such storm drain pipelines.
- C. The size and configuration of the various components shall be as indicated herein, in the Standard Details, and in the approved Improvement Plans, if any.
- D. All materials and installation shall be in accordance with the standards and specifications of the Solano Irrigation District, latest revisions.

##### 1.02 REFERENCED DOCUMENTS

- A. This specification references American Society for Testing and Materials (ASTM) standard specifications, which are made a part hereof by such reference and shall be the latest edition and revision thereof.
- B. F-1216 - Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin Impregnated Tube.
- C. F-1743 – Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP).
- D. D-638 - Test Method for Tensile Properties of Plastics.
- E. D-790 - Test Method for Tensile Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
- F. D-5813 - Standard Specifications for Cured-In-Place Thermosetting Resin Sewer Piping Systems.

### 1.03 DESCRIPTION OF WORK

- A. It is the intent of this specification to provide for the reconstruction of existing monolithic concrete irrigation pipelines by forming a new pipe within an existing structurally sound but cracked and leaking pipe that has generally maintained its original shape. The process is defined as the reconstruction of existing pipelines by installation of a thermosetting resin impregnated flexible felt fiber tube with an impermeable inner surface. The resin-impregnated tube is formed to the host pipe utilizing a water column. Curing is accomplished by circulating hot water (or other approved method) throughout the length of the tube to cure the thermosetting resin into a hard, impermeable pipe, in accordance with the specified curing schedule supplied by the resin manufacturer.
- B. The cured-in-place pipe (CIPP) shall provide flow capacity equal to or greater than 100 percent of the original pipe's flow capacity, when the original pipe was new.
- C. The CIPP shall extend the full length of the original pipe and shall provide a structurally sound, impermeable, jointless liner close fitting to the host pipe.
- D. The work shall be done after irrigation water deliveries are completed for the season. Flow bypassing will not be required.

### 1.04 SAFETY

- A. The Contractor shall particularly conform to applicable safety regulation pertaining to confined space procedures. Refer to General Conditions section 00700.6.10.

### 1.05 DESIGN CONDITIONS

- A. Service conditions are as shown in the Drawings. Per ASTM F-1216, the pipe is partially deteriorated. The groundwater level should be below the pipe and the ground may be saturated during the rainy season while the pipe is empty.

### 1.06 REQUIRED SUBMITTALS

- A. The Contractor shall be responsible for submitting to the Engineer for approval the following:
  - 1. CIPP design
  - 2. Liner product information
  - 3. CIPP samples
  - 4. CIPP test results from pre-installation testing
  - 5. Felt impregnation site
  - 6. Contractor's installation procedure

## **PART 2 MATERIALS**

### **2.01 FLEXIBLE FELT TUBE**

- A. The tube shall consist of one or more layers of flexible needled felt material or an equivalent nonwoven or woven material capable of carrying resin and withstanding installation pressures, have sufficient strength to bridge missing pipe, and withstanding curing temperatures. The outside layer of the tube shall be coated with an impermeable, flexible membrane that will contain the resin and allow the resin impregnation (wet out) procedure to be monitored. The tubing shall be properly sized to the diameter and length of the irrigation pipe to be rehabilitated and be able to stretch to fit irregular pipe sections.
- B. The tube shall be marked for distance at regular intervals along its entire length, not to exceed 5 ft. Such markings shall include the manufacturers name or identifying symbol.

### **2.02 RESIN/CATALYST:**

- A. The liquid thermosetting resin used to impregnate the tube shall produce a properly cured tube which will be resistant to abrasion due to solids, grit and sand. The cured tube shall also be resistant to corrosion due to acids and gases such as sulfuric acid, carbonic acid, hydrogen sulfide, methane and carbon monoxide. The resin selected shall have proven resistance to raw, untreated water used for irrigation.
- B. The resin system shall be a corrosion resistant polyester or vinyl ester system including all required catalysts and initiators that when cured within the tube create a composite that satisfies the requirements of ASTM F1216, ASTM D5813 and ASTM F1743, the physical properties herein, and those which are to be utilized in the submitted and approved design of the CIPP for this project. The resin shall produce a CIPP that will comply with the structural and chemical resistance requirements of this specification.

### **2.03 TUBE IMPREGNATION**

- A. The Contractor will designate a location where the felt tube will be impregnated. The quantity of resin used for tube impregnation shall be sufficient to fill the volume of air voids in the tube with additional allowances for polymerization shrinkage and the loss of resin through cracks and irregularities in the original pipe wall. A vacuum impregnation process shall be used, and a roller system shall be used to uniformly distribute the resin throughout the tube.
- B. The tube should be vacuum impregnated with resin (wet-out) under controlled conditions. The volume of resin used should be sufficient to fill all voids in the tube material at nominal thickness and diameter. The volume should be adjusted by adding 5 to 10 % excess resin for the change in resin volume due to polymerization and to allow for any migration of resin into the cracks and joints in the original pipe.

## PART 3 EXECUTION

### 3.01 STRUCTURAL REQUIREMENTS

A. The CIPP thickness shall be calculated and designed based upon the following physical condition of the existing pipe to be rehabilitated.

1. All pipes shall be designed in accordance with ASTM F-1216 specifications.
2. All pipes shall be subjected to soil load of 120 lbs./cu.ft., when applicable.
3. All pipes may have a minimum of 2% ovality in the circumference.

Note: Conditions 1 and/or 3 may change after the video inspection and later case-by-case design calculations.

### 3.02 CONDITIONS OF PREPARATION

A. Entry into the existing monolithic concrete pipeline will be made from an existing above ground concrete box structure. The concrete structure typically has an interior dimensions of four feet square (4'x4') or four feet by six feet (4'x6') with an exterior height of eight to ten feet above grade. The concrete structures are free standing without ladders, stairs or pedestrian access points.

### 3.03 INSTALLATION PREPARATION

- A. The Contractor shall execute his operations in strict accordance with all Cal/OSHA and manufacturer's safety requirements. Particular attention is required for those safety requirements involving working with scaffolding, entering confined spaces and operations with hot media.
- B. The interior of the pipeline shall be carefully inspected by remote video methods to determine the location of any conditions which may prevent proper installation of the lining into the pipelines. The locations shall be noted so that these conditions can be corrected before the installation of the CIPP. Inspection of the pipeline shall be performed by experienced personnel trained in locating breaks, obstacles, and service connections by closed-circuit television. The District shall be given and keep a videotape and suitable log for later reference.
- C. It shall be the Contractor's responsibility to remove all debris located within the irrigation pipe to the degree required by the liner manufacturer and dispose of debris in accordance with all applicable laws and regulations, at the Contractor's expense.
- D. It shall be the responsibility of the Contractor to conduct a videotape inspection of the irrigation pipe immediately before insertion of the resin impregnated tube to assure that the pipe is clean and existing pipe conditions are acceptable for lining.

- E. The Contractor shall be responsible to correct internal pipe conditions that prevent proper installation of the liner.

### 3.04 INSTALLATION PROCEDURE

- A. The resin-impregnated felt tube shall be inserted through an existing concrete box structure by means of an inversion ring, standpipe, or pulled-in-place, capable of applying the hydrostatic head required to fully extend the tube to the next designated structure. The tube shall be inserted into the inversion standpipe, and then the tube shall be turned inside out and attached to the inversion standpipe so that a leak-proof seal is created. The inversion head shall be adjusted to a sufficient height to invert the tube from structure to structure and to hold it tightly against the existing pipe wall, producing dimples at side connections and flared ends at the structure boxes. Care shall be taken not to over-stress the felt tube at the elevated curing temperatures, which may cause damage or failure prior to cure. The Contractor is responsible for providing any special equipment or stands to direct the liner over the top of and into the concrete box structure.
  - 1. The Contractor may remove any existing slide gates to access the monolithic concrete pipeline entrance and exit. If the gates are removed, the Contractor must replace the gates when the work has been completed. The removal and replacement of the slide gates shall be at the Contractor's expense.
- B. After the inversion is completed, the Contractor shall supply a suitable heat source, water source, and water recirculation equipment capable of delivering heated water throughout the section to uniformly raise the water temperature above the temperature required to affect a cure of the resin. The appropriate temperature shall be recommended by the resin/catalyst system manufacturer.
  - 1. It is recommended that the curing procedure utilize an environmentally safe steam cure.
  - 2. If the use of hot water is necessary, the water must be collected and properly disposed of by the Contractor, at the Contractor's expense. The Contractor may be required to provide the District with a copy of the National Pollutant Discharge Elimination System (NPDES) permit.
- C. The heat source shall be fitted with suitable monitors to gauge the temperature of the incoming and outgoing water supply. Another such gauge shall be placed between the impregnated felt tube and the host pipe in the upstream and the downstream concrete structures to determine the temperatures during cure. Water, or steam, temperature in the line during the cure period shall not be less than 150° F or more than 200° F as measured at the heat source return line. Initial cure may be considered completed when the exposed portions of the felt tube pipe appear to be hard, and the remote sensing device indicates the temperatures to be adequate, as recommended by the resin/catalyst system manufacturer.

- D. The Contractor shall cool the hardened CIPP to a temperature below 100 degrees Fahrenheit before relieving the water column or steam pressure. Cool water may be added to the water column while draining hot water from a small hole at the opposite end of the CIPP, so that a constant water column height is maintained until cool-down is completed. Care shall be taken in the release of the water column to avoid vacuum development, which could damage the newly installed CIPP.
- E. The finished pipe shall be continuous over the entire length of the inversion run between the two access points and be as free, as commercially possible, from significant defects. Any defects which will affect, in the foreseeable future or warranty period, the integrity or strength of the pipe shall be repaired in a manner mutually agreed upon by the Engineer and the Contractor. Said repairs shall be funded and implemented by the Contractor.

### 3.05 INSPECTION

- A. After the work is completed, the Contractor shall provide the Engineer with a videotape showing both the before and after condition. Visual inspection of the CIPP shall be in accordance with ASTM F1743, Section 8.6.
- B. After installation, CIPP samples shall be prepared for each installation or approximately 20% of the project's installations. Pipe physical properties will be tested in accordance with ASTM F1216 or ASTM F1743, Section 8, using either method proposed.
- C. Wall thickness of samples shall be determined as described in paragraph 8.1.6 of ASTM F1743. The minimum wall thickness at any point shall not be less than 87½% of the submitted minimum design wall thickness calculated.

### 3.06 TESTING REQUIREMENTS

- A. Hydraulic Capacity - Overall, the hydraulic cross-section shall be maintained as large as possible. The CIPP shall have a minimum of the full flow capacity of the original pipe before rehabilitation. Calculated capacities will be derived using a commonly accepted roughness coefficient for the original pipe material in its new condition.
- B. Leakage Test per ASTM standards F-1216 section 8.2 and F-1743 section 8.2.
- C. Short-term flexural (bending) properties test per ASTM F-1216 section 8.1.3.1.
- D. De-lamination test per ASTM F-1216 section 8A.

### 3.07 CLEAN UP

- A. After the installation work has been completed and all testing acceptable to the Engineer, the Contractor shall clean up the entire project area to its original pre-construction condition. All excess material and debris not incorporated into the

permanent installation shall be disposed of by the Contractor, at the Contractor's expense.

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## SECTION 02519

### CONDUCTIVE TRACE WIRE FOR NONMETALLIC PIPE INSTALLATION

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. This section covers the requirements for the installation of a conductive trace wire during the installation of nonmetallic water distribution pipelines. It will be used for locating the pipelines, laterals, services and appurtenances with an electronic pipe locator after installation.
- B. All materials and installation shall be in accordance with the standards and specifications of the Solano Irrigation District, latest revisions.

##### 1.02 RELATED SECTIONS

- A. Section 01100 – General Requirements
- B. Section 02513 – Gravity Irrigation Pipelines (RGRCP)
- C. Section 02514 – Gravity Irrigation Pipelines (PVC)
- D. Section 02515 – Pressurized Non-Potable Water Systems
- E. Section 02516 – Domestic Water Systems

##### 1.04 SUBMITTALS

- A. The Contractor shall submit the manufacturer's data on materials furnished that indicate compliance with the specifications regarding materials used.

##### 1.05 MEASUREMENT AND PAYMENT

- A. There is no separate payment for the supply and installation of tracer wire on any construction or installation of water main by the Contractor. The Contractor shall consider the supply and installation of the tracer wire incidental to all construction of water main.

#### PART 2 MATERIALS

##### 2.01 TRACE WIRE

- A. Open-Trench Installation: direct burial #12 AWG Solid (0.0808" diameter), steel core soft drawn tracer wire, 250# average tensile break load, 30 mil high molecular-high density polyethylene jacket complying with ASTM-D-1248, 30

volt rating. Color shall be “blue” for domestic water (potable) pipelines and “purple” for raw water (non-potable) pipelines. Manufactured by Copperhead Industries part number 1230-SF, or approved equal.

- B. Directional Bore or Jacked Installation: direct burial #12 AWG Solid (0.0808” diameter), steel core hard drawn extra high strength horizontal directional drill tracer wire, 1150# average tensile break load, 45 mil high molecular-high density polyethylene jacket complying with ASTM-D-1248, 30 volt rating. Color shall be “blue” for domestic water (potable) pipelines and “purple” for raw water (non-potable) pipelines. Manufactured by Copperhead Industries part number 1245-HS, or approved equal.

## 2.02 CONNECTORS

- A. Splices along the continuous run of trace wire for repair of a wire break or replacement of failed segment of wire shall use 3M Brand DBR Direct Bury Splice Kit or approved equal. Approved alternatives must securely connect two or more wires, effectively moisture seal by means of a dielectric non-hardening silicone sealant, manufacturer approved for direct burial and rated for a minimum of 50V.
- B. Branch connections for laterals, turnouts, services and appurtenances shall use DryConn Direct Bury Lug Aqua, or approved equal. Approved alternatives must securely connect one or two wires to the main trace wire without cutting the main trace wire, effectively moisture seal by means of a dielectric non-hardening silicone sealant, manufacturer approved for direct burial and rated for a minimum of 50V.

## PART 3 EXECUTION

Trace wire shall be installed on all water mains and appurtenances. The wire shall be installed in such a manner as to be able to properly trace all pipelines and services without loss or deterioration of signal or without the transmitted signal migrating off the tracer wire.

### 3.01 INSTALLATION

- A. Trace wire shall be installed in the same trench and inside bored holes and casing with pipe during pipe installation. It shall be secured to the pipe as required to insure that the wire remains adjacent to the pipe. The trace wire shall be securely bonded together at all wire joints with an approved watertight connector to provide electrical continuity, and it shall be accessible at all trace wire access points.
- B. Except for approved spliced-in repair or replacement connections, tracer wire shall be continuous and without splices from each trace wire access point.
- C. Trace wire access points shall be accessible at all new water valve boxes, water

meter boxes, blowoffs, ARVs, fire hydrants, irrigation turnouts and access manholes. Concentrations of multiple proposed valves near pipe intersections, i.e. tees or crosses, may require more than one access point assembly in each concrete valve box collar. Trace wire access points shall be within public right-of-way or public utility easements.

1. If the spacing of valves and meters is greater than one-half (1/2) mile, the trace wire shall be looped up in a 2" PVC pipe to be located at a right-of-way fence line or at a cross fence line, as applicable, for protection. A PVC cap shall be placed on the 2" pipe when used, but it shall not be solvent welded onto the pipe.
- D. At the point of connection between ductile iron water mains, with any non iron water main, the tracer wire shall be properly connected to the iron pipe with a cad weld or approved equivalent. Tracer wire welds shall be completely sealed with the use of an approved mastic type sealer specifically manufactured for underground use. Mastic shall be applied in a thick coat a minimum of one-quarter inch (1/4") thick and shall be protected from contamination by the backfill material with the use of a plastic membrane.
- E. Tracer wire shall be laid flat and securely affixed to the pipe at 10 foot intervals. The wire shall be protected from damage during the execution of the works. No breaks or cuts in the tracer wire or tracer wire insulation shall be permitted. At water service saddles, the tracer wire shall not be allowed to be placed between the saddle and the water main.
- F. At all water main end caps, a minimum of 6 feet of tracer wire shall be extended beyond the end of the pipe, coiled and secured to the cap for future connections. The end of the tracer wire shall be spliced to the wire of a six pound zinc anode and is to be buried at the same elevations as the water main.

### 3.02 BRANCHED CONNECTION

- A. Connections between the main line tracer wire and branch connection tracer wire shall only be allowed at services, ARVs, blowoffs, irrigation turnouts and laterals.
- B. The branch connection tracer wire shall be a single tracer wire properly spliced to the main line tracer wire. DryConn Direct Bury Lug Aqua water tight connectors, or approved equal, shall be used to provide electrical continuity.

### 3.03 DIRECTIONAL BORING

- A. For directional boring installations, two #12 tracer wires, listed above, shall be installed with the pipe and connected to the tracer wire at both ends, or cad welded to the existing iron pipe at both ends.

- B. The tracer wires shall be laid flat and securely affixed to the top and side of the pipeline at five foot (5') intervals to insure its placement during the boring operation.

#### 3.04 TESTING REQUIREMENTS

- A. Contractor shall perform a continuity test on all trace wire in the presence of the Engineer or the Engineers' representative. If the trace wire is found to be not continuous after testing, Contractor shall repair or replace the failed segment of the wire.

#### 3.05 REPAIR / RESTORATION

- A. At all repair locations where there is existing tracer wire, the tracer wire shall be properly reconnected and spliced as outlined above.

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## SECTION 02520

### GRAVEL PACKED WATER WELL

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Gravel packed water well includes drilling, installing, cleaning, developing, testing, videoing, abandoning, and site clean up.
- B. Well construction shall be in conformance with the water well ordinance of Solano County.
- C. Existing wells shall be abandoned in accordance with the requirements of the Water Well Ordinance of Solano County.

##### 1.02 RELATED SECTIONS

- A. Section 01100 – General Requirements
- B. section 01570 – Temporary Erosion and Sediment Control

##### 1.03 SUBMITTALS

- A. The Contractor shall submit the original electronic log, an electronic copy, and an interpretation of the log.
- B. The Contractor shall submit their recommendation for the location of the perforated casing and gravel pack sieve size.
- C. The Contractor shall submit a specification sheet for the blank and perforated casing, including confirmation of the mill slot size and density.
- D. The Contractor shall submit their recommended type of base shoe for District approval.

##### 1.04 GUARANTY

- A. The contractor shall guarantee that all materials and workmanship performed are free from defects for a period of two years after acceptance. If any part of the work shall fail within this period, it shall be restored to operation at no cost to the District. Defects to be covered by this guarantee include:
  - 1. Water from the well shall clear up within one hour after operating pump at design flow.

2. Collapse of casing or screen due to causes other than Acts of God.

## 1.05 MEASUREMENT & PAYMENT

- A. The payment for drilling, logging, electric log, providing gravel base for drilling operations, casing, perforations, gravel packing, grouting, developing, testing, conductor casing, concrete base, access pipe, gravel fill pipe, video survey, water quality testing, well chlorination, guaranty of the well, removal of the existing pump and motor, existing well abandonment, discharge water filtration, and clean up of the drilling mud and cuttings will be included in the applicable unit or lump sum price in the Schedule for the various measured components of the work. This price shall include the cost of all labor, materials, equipment, apparatus, testing, taxes, and permits necessary to furnish the District a producing water well.

## PART 2 MATERIALS

### 2.01 CASING

- A. The steel for casing shall conform to ASTM A53 Grade B, or ASTM A139 Grade B. The casings shall be fabricated with only one longitudinal seam or spiral weld. Casings shall be fabricated in 24-foot lengths minimum with the ends machined perpendicular to the axis.
- B. The conductor casing for the well shall be of a sufficient size to accommodate the drilling head and to allow enough space for the gravel fill tube, access pipe, and casing vent. The conductor casing wall thickness shall be standard wall. The project drawings will be referred to for the appropriate size.
- C. The steel well casing shall be specified by the Engineer and have a standard wall thickness. To assist in centering the casings in the hole, four guides shall be welded on the outside at sixty-foot (60') spacing. The casing size and centering guides configuration will be specified on the project drawings.
- D. Four-inch (4") welding collars of the same material as the casing pipe shall be provided for the welded joints. Three (3) alignment holes 1 inch by 3/8 inch shall be provided in each collar to insure proper matching sections.
- E. Perforated casing joints shall be fabricated in the same manner as a conventional casing joint. The perforated casing shall be provided with vertical slot openings. Slot openings shall be machine made with opening parallel to the axis of the casing and shall be "Triple Slot," tapered or keystone cut, as manufactured by Wilson Industries or approved equal.
  1. Slots made in perforated casing by cutting torch will not be accepted.

## 2.02 GRAVEL ENVELOPE

- A. The gravel shall be as furnished by Silica Resources, Inc., Colorado Silica Sand, Inc. or approved equal.
- B. The gravel size shall be recommended by the Contractor and approved by the Engineer.
- C. The use of crushed rock will not be permitted.

## 2.03 GROUT SEAL

- A. The grout seal shall contain a minimum 5 ½ sacks of cement (Type II) per cubic yard and a maximum of 7 gallons of water per sack of cement. The maximum slump shall be 4 inches. The maximum aggregate size will be 3/8 inch.

## 2.04 CONCRETE BASE AND WELL CAP

- A. The concrete shall have a minimum compressive strength of 3,000 psi. All cement shall be type II Portland cement with a minimum of 5 sacks of cement per cubic yard of concrete.

# PART 3 EXECUTION

## 3.01 DRILLING

- A. The Contractor shall furnish all labor, materials, equipment, tools and apparatus necessary to provide a reverse-rotary gravel packed water well. The well will be of the gravel packed and cased design as shown on the Drawing. The Contractor shall be responsible for obtaining the required well permit from Solano County, then shall drill, prepare a driller's log, provide electrical log, furnish and install conductor casing, furnish and install well casing, furnish and install gravel, furnish and install cement seal, furnish and install sanitary seal, swab, develop, test, construct concrete base, clean up site, and do all else required to provide a satisfactory well. All materials shall be new and conform to the Specifications as outlined.
- B. The Contractor shall be responsible for hauling in gravel base, as required, to stabilize the construction area used for drilling operations.
- C. The District will identify a drainage ditch for the contractor to discharge into. For the disposal of development and testing water the Contractor shall filter the water through an advanced filtration system. All water leaving the site should appear clean and free of turbidity in accordance with CA Stormwater BMP Handbook - Construction.
- D. A pilot hole shall be drilled to the depth specified by the Engineer. The diameter of the pilot hole shall be not less than eight inches (8"). After conducting an electric

log and analyzing samples, and if the site is determined acceptable, either this hole may be reamed out for the irrigation well, or the final well site will be shifted a minimum distance of twenty (20) feet from the pilot hole. The final hole shall be installed at the location indicated on the Drawing. The well shall be opened to a the necessary diameter to accommodate the conductor casing specified by the Engineer to a minimum depth of 50 feet or to a point where it will be supported on firm clay and be of sufficient size to allow at least four inches (4") of grout around the conductor casing. At the Contractor's option, he may install the conductor casing prior to drilling the pilot hole if it is required for stability of the drilling operation. After the annular space around the conductor has been sealed with a grout slurry and upon the direction of the District, the well shall be drilled to a minimum diameter of the well casing size plus twelve inches (12") or as specified in the contract drawings, for the remainder of the design depth of the well, as determined by the driller's log and electric log, and the casing shall then be installed.

- E. The Contractor's equipment shall be of the proper type and shall be in good condition so that the work can be done without any interruption. Drill collars of sufficient size and length shall be installed to maintain plumbness. The well shall be constructed in accordance with the applicable provisions of AWWA A100 Standard for "Water Well" and DWR Bulletin 74-81 and 74-90.
- F. **When the drilling is undertaken, the work shall be continuous on a 24-hour per day basis until the gravel pack is installed.** Particular attention shall be paid to the specific gravity and character of the mud-laden fluid used, so that the production of the aquifers will not be impaired. The Contractor shall check the well for plumbness and alignment to a depth of 600 feet. The procedure used will be that set forth in Section 8 of AWWA A100. The District will judge whether any deviation will impair the installation and operation of the pumping equipment.

### 3.02 ELECTRONIC LOG

- A. The electric log shall consist of one spontaneous potential curve and two resistivity curves. The electric log shall be performed by Schlumberger, Welenco, or approved equal.

### 3.03 SOIL SAMPLES

- A. The Contractor shall take samples of the aquifer material at ten-foot (10') intervals, place them in plastic bags, and save them for inspection by the District. The Contractor shall perform sieve analysis on selected samples for sizing the gravel pack and slot openings.

### 3.04 INSTALLATION

- A. The location of the slotted openings will be determined from the E-log. There shall be sufficient open area to transmit the desired yield at an aperture entrance velocity equal to, or less than, 0.1 feet per second.

- B. A temporary steel cap shall be tack welded to the casing pipe at all times when work is not being done and/or the well site is not attended.
- C. The casing shall be suspended until all placement of gravel and grout is completed.
- D. After the installation of casing has been completed, water shall be introduced into the circulating fluid to properly thin the drilling mud without endangering the wall structure. When the circulating fluid reaches the desired viscosity, the Contractor may then start the installation of gravel.
- E. The annular space between the casing and the bore hole shall be carefully and completely packed with gravel. The gravel shall be cleaned and washed and shall be composed of well-rounded particles.
- F. The gradation of the gravel shall be carefully selected by the Contractor with reference to the character of the water bearing strata's. Extreme care shall be taken to avoid creating bridging or cavities in the envelope by placing the gravel into the annular space through a tremie pipe for the full depth.
- G. The Contractor shall constantly check by suitable means the actual position of the gravel. The Contractor shall furnish to the District records showing the amount of gravel introduced into the annulus of the well in order that a comparison can be made as to the total amount required to properly fill the space.
- H. The annular space between the casing and the bore hole for the upper 50 feet, or as shown on the Drawing, shall be carefully and completely filled with grout in accordance with DWR Bulletins 74-81 and 74-90.
- I. The grout shall be placed in the annulus through a filler pipe. Extreme care shall be taken to avoid creating any cavities or voids in the grout seal.
- J. The Contractor shall construct a reinforced concrete base as shown on the Drawing. A temporary steel cap shall be tack welded to the casing pipe.
- K. A gravel filler pipe, two access pipes, and vent pipe shall be installed as shown on the Drawing.
- L. At the completion of the well construction, the casings and pipes shall be extended to a point above the drilling level to match the final elevation. The Contractor shall dispose of all drilling mud and cuttings that remain adjacent to the well site. The drilling mud and cuttings will be allowed to dry and then will be stockpiled. Working in coordination with the District and the adjacent landowner, the Contractor may be able to dispose of the material along farm roads adjacent to the site. The Contractor shall be responsible for obtaining a Solano County Grading Permit, if necessary, before any spreading of materials.
- M. The final driller's log shall show diameter, wall thickness, depths and quantities of casing and screens installed, type, aperture size, and pattern of perforations, bore

hole diameters, cemented sections, gradation of gravel envelope, quantity of gravel initially installed, quantity of gravel added during development operations; an all other pertinent details. The Contractor will file the necessary data with Solano County and the State of California.

### 3.05 CLEANING, DEVELOPING, AND TESTING

- A. After completing the grout seal in the upper portion of the well, the well shall be thoroughly swabbed and cleaned again to remove any material that may have settled at the bottom. The Contractor shall then add any additional gravel required. The well shall then be developed. The Contractor shall develop the well by such methods as will effectively extract from the water-bearing formations the maximum practical quantity of sand, drilling mud and other fine materials in order to bring the well to maximum yield per foot of drawdown.
- B. Compressed air, surge plungers, high velocity jetting equipment and pumps may be used for the development work.
- C. This work must be done in a manner that does not cause undue settlement and disturbance of the strata above the water-bearing formation. The well shall be pumped at varying rates to a maximum rate of 2500 gallons per minute, or as specified by the Engineer, for not less than 24 hours. The pump installation shall include a flow meter which indicates in gallons per minute and a throttling valve downstream of the meter. Development of the well shall be continued until water pumped from the well at the test pumping rate is clear and free of sand. The water shall be considered sand-free when the average rate of sand production over a 4 hour period including pump start-up is less than 10 parts per million by volume.
- D. The District may require additional development work aimed to further improve the specific capacity of the wells. Following development of the well, pumping shall then cease for not less than 12 hours. The well shall then be test pumped. A constant rate test pumping program shall be conducted by operating the pump at the design rate of 2,000 gallons per minute for a period of 8 hours or as determined by the Engineer. In some cases, the Engineer may require the well to be test pumped at varying flow rates for a set period of time. Readings of the pumping rate and water level shall be made every minute for the first ten minutes of test, every two minutes for the next ten minutes of test, every five minutes for the next forty minutes, every ten minutes for the next hour, every thirty minutes for the next three hours and hourly for the remainder of the pumping period. Recovery water level measurements shall be made with the same frequency beginning with pump shutoff. The District will assist in the collection of this data.
- E. Following test pumping the well shall be chlorinated by the addition of chlorine to establish a 200 ppm residual in the well for 24 hours. On the second day dry ice shall be added in 5 pound increments to agitate the well water. Following the completion of the initial agitation another 5 pounds of dry ice shall be added until a total of 50 pounds has been added. Chlorine compounds are both volatile and

corrosive and handling of all chemicals shall be performed using appropriate safety procedures to prevent eyes and skin from coming in contact with the chlorine.

### 3.06 VIDEO SURVEY

- A. The Contractor shall provide a video survey of the completed well in DVD format (two (2) copies required) which clearly shows all of the blank and perforated well casing installed from ground surface to the bottom of the well. The video shall be labeled to accurately indicate the depth as the camera progresses down the well.
- B. The video camera shall view the well casing by rotation both vertically and horizontally as required.

### 3.07 ABANDONMENT

- A. Following completion of the new well and with the approval of the District, the Contractor shall abandon the existing well as shown on the drawings and in accordance with the requirements of the Water Well Ordinance of Solano County. Data on the diameter and depth of the existing well will be provided. The abandonment shall include removal and disposal of the existing pump, motor, and column piping. The District retains the right to salvage any of the abandoned equipment for their use following removal.

### 3.08 SITE CLEAN UP

- A. The Contractor shall restore the site to its original condition before construction began.

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## SECTION 02600

### DRAINAGE PIPELINES

#### **PART 1 GENERAL**

##### 1.01 SECTION INCLUDES

- A. Pipe, fabricated bends, connecting bands, and all other material required to assemble the pipe shall be furnished by the Contractor.
- B. The size and configuration of the various components of the water system shall be as indicated herein, in the Standard Details, and in the approved Improvement Plans, if any.
- C. All materials and installation of the system shall be in accordance with the standards and specifications of the Solano Irrigation District, latest revisions.

##### 1.02 RELATED SECTIONS

- A. Section 01100 – General Requirements
- B. Section 02300 - Earthwork

##### 1.03 MEASUREMENT AND PAYMENT

- A. Drainage pipe will be measured in linear feet of pipe in place, and will be paid for at the unit price per foot bid therefor in the Bid Schedule, and will be in addition to the unit price in the Bid Schedule for fabricating bends. Where additional width of CMP coupling band is directed by the Engineer, the additional width will be paid for at the unit price bid in the schedule per linear foot of pipe.
- B. Flashboard risers will be paid for at the applicable unit price bid therefor in the Bid Schedule. Drain piping from the riser to the drain is not included, and will be bid separately.

#### **PART 2 MATERIALS**

##### 2.01 CORRUGATED METAL PIPE

- A. The pipe shall be aluminized steel corrugated metal pipe (CMP) as shown on the drawings. The base metal and fabrication for aluminized pipe shall conform to AASHTO Designation M 36. Lifting lugs shall be provided on the pipe to prevent damage to the exterior coating.
- B. The pipe shall be shipped and handled in such a manner as to prevent damage to the protective coating. Any pipe damaged beyond repair, in the opinion of the

Engineer, shall be replaced by the Contractor at his own expense. Connection band bolts and damaged coating shall be coated thoroughly with asphalt as directed by the Engineer.

- C. All connecting bands shall be a minimum of twelve inches (12") wide and of the same gage and material as the pipe or as recommended by the pipe manufacturer.

## 2.02 POLYETHYLENE PLASTIC DRAIN PIPE

- A. Pipe shall be rubber gasketed black N-12 Low Head Irrigation pipe (5.0 psi) corrugated, smooth invert, high density polyethylene (HDPE), in accordance with AASHTO M-294, as manufactured by Advanced Drainage Systems, or approved equal.
- B. Non-gasketed couplers may be acceptable as approved by the Engineer.

## 2.03 FLAP GATES

- A. Flap gates shall have cast iron frames and covers that provide free outflow while sealing against backflow under at least a 10-foot seating head. Frames shall be the "spigot back" type, suitable for attaching to corrugated drain pipe. Flap gates shall be Waterman Model F-10, or approved equal.

## 2.04 FLASHBOARD RISERS

- A. Flashboard risers shall be fabricated to the height, width and outlet pipe diameter specified in the Drawings. Channel frames shall be sufficient to install 2" nominal thickness lumber flashboards. Flashboard risers fabricated of aluminized corrugated steel shall be by Contech Construction Products, or approved equal. Flashboard risers fabricated of HDPE shall be by Poly Riser and Pipe of Willows, CA, or approved equal.

# PART 3 EXECUTION

## 3.01 DRAINAGE PIPE HANDLING, LAYING AND ASSEMBLY

- A. Refer to Section 02300 – Earthwork, subsection 3.12 – Trenching for Pipe and subsection 3.13 – Backfill of Pipe. Drainage piping and appurtenances shall be installed per the manufacturer's recommendations. As each unit of pipe is laid, sufficient soil shall be tamped about the pipe to hold it rigidly in position.

## 3.02 FLASHBOARD RISER INSTALLATION

- A. Flashboard risers shall be installed to the elevations shown in the Drawings. Flashboards shall be installed, and bolted in place if required by the District.

/// END OF SECTION

## SECTION 02730

### GRAVEL ROAD SURFACING

#### **PART 1 GENERAL**

##### 1.01 SECTION INCLUDES

- A. The Contractor shall furnish road gravel and shall haul and place the gravel for surfacing on operating roads and other roads where directed the Contract Documents, Drawings or by the Engineer.
- B. The size and configuration of the various components shall be as indicated herein, in the Standard Details, and in the approved Improvement Plans, if any.
- C. All materials and installation shall be in accordance with the Standards and Specifications of the Solano Irrigation District, latest revisions.

##### 1.02 RELATED SECTIONS

- A. Section 01100 – General Requirements
- B. Section 02300 - Earthwork

##### 1.03 PAYMENT

- A. Measurement for payment of gravel material will be made of only such quantities as are required for the volume of roadway surfacing. The quantity of material will be paid for at the unit price bid therefor in the Bid Schedule for furnishing and placing gravel surfacing for roads.

#### **PART 2 MATERIALS**

##### 2.01 ROAD GRAVEL

- A. Gravel material shall be bank-run gravel, except that rock larger than one and one-half inches (1½”) shall be removed from the road surfacing material. Sticks, weeds and excessive amounts of other organic substances will not be permitted in the surfacing material.

#### **PART 3 EXECUTION**

##### 3.01 ROADWAY PREPARATION

- A. Before placing the gravel surface on operating roads, the roadway shall be graded uniformly throughout the length and width of the road. Where gravel surfacing is required for county roads, the subgrade shall be prepared as provided for in

Section 02300.3.07 – Compacted Embankments.

3.02 GRAVEL PLACEMENT

- A. Unless otherwise directed by the Engineer, the gravel surfacing shall be placed uniformly to an average thickness of six (6) inches to the widths and lengths provided the Contract Documents, Drawings or by the Engineer. The Contractor shall arrange his surfacing operation so that the equipment used shall be routed over the full width and length of previously deposited surfacing material to obtain the maximum compacting effect by the wheels. Elevated canal banks may require the use of a vibrating drum roller in order to achieve the required compaction level for the entire width of the roadway. The finished road shall be graded to a smooth uniform surface and maintained in such a manner until final acceptance by the District.
- B. Resurfacing of existing gravel roads shall be in kind per the specifications or the public agency in authority over the job site.
- C. Where existing rock road surfacing has been salvaged for reuse, it shall be placed and compacted in accordance with this Section.

/// END OF SECTION

## SECTION 02740

### ASPHALTIC CONCRETE PAVING

#### **PART 1 GENERAL**

##### 1.01 SECTION INCLUDES

- A. The work consists of furnishing all materials, labor and equipment necessary for placement of asphaltic concrete paving over a properly prepared subgrade, including the base course, redwood header boards, prime coat, tack coat, surface courses, seal coat and all other appurtenant work as shown on the Drawings, the Standard Details or as specified herein.
- B. The size and configuration of the various components shall be as indicated herein, in the Standard Details, and in the approved Improvement Plans, if any.
- C. All materials and installation shall be in accordance with the Standards and Specifications of the Solano Irrigation District, latest revisions.

##### 1.02 RELATED SECTIONS

- A. Section 01100 – General Requirements
- B. Section 02300 - Earthwork

##### 1.03 REFERENCES

- A. State of California, Department of Transportation Standard Specifications, referred to below as CALTRANS.

##### 1.04 PAYMENT

- A. Measurement for payment of asphalt concrete surfacing will be made of only such quantities as are required for the area of roadway surfacing. The quantity of material will be paid for at the unit price bid therefor in the Bid Schedule for furnishing and placing asphalt concrete surfacing for roadways. This payment shall include base rock, concrete curb removal, prime, tack and seal coats, asphalt concrete, sterilant, header board, and all other labor and materials which shall be necessary and/or required to complete asphaltic concrete.

#### **PART 2 MATERIALS**

##### 2.01 ASPHALTIC MATERIALS

- A. Asphalt Binder: grade AR 4000 steam-refined paving asphalt per CALTRANS section 92.

B. Asphalt Emulsions:

1. Prime Coat: grade MC70 liquid asphalt per CALTRANS Section 93.
2. Tack Coat: grade MS1 asphaltic emulsion per CALTRANS Section 94.
3. Fog Seal Coats: materials for fog seal coats shall meet the requirements of CALTRANS Sections 37 and 94, and be an SS1 type asphaltic emulsion.

2.02 AGGREGATE

- A. Aggregate Base: shall conform to CALTRANS Section 26 for Class 2 Aggregate Base.
- B. Aggregate for Asphalt Concrete: Type B per CALTRANS Section 39, ¾" maximum, medium graded.

2.03 REDWOOD HEADERS

- A. Redwood headers and stakes shall be 2x8 dimensional construction grade redwood or approved equal.
- B. Header boards shall be fastened to stakes using twelve penny (12d) galvanized nails.

**PART 3 EXECUTION**

3.01 SURFACE PREPARATION

- A. Subgrade Preparation: Following excavation and grading, the subgrade shall be scarified and compacted for a minimum depth of six (6) inches to 95% of the maximum dry density, as determined by ASTM Test Method D-1557. Procedures outlined in CALTRANS Section 24 shall be followed.
- B. Subgrade Sterilization: A soil sterilant such as Karmex or equal shall be applied at the manufacturer's recommended rate to the soil surface prior to the placement of the base course.
- C. Sawcutting: Existing pavement and concrete to be paved against shall be sawcut in neat straight lines.

3.02 HEADERS

- A. The perimeter of the asphalt surface shall be enclosed by redwood header. Where vertical concrete surfaces exist, these may be used in lieu of installing a header.

### 3.03 BASE COURSE

- A. The base course shall be placed and compacted in conformance with CALTRANS Section 26.

### 3.04 PRIMING AND TACKING

- A. A prime coat shall be applied to the base course in accordance with CALTRANS Section 39. Prime coat shall be applied at 0.25 gallon per square yard, or as directed by the Engineer.
- B. A tack coat shall be applied to vertical surfaces, other than redwood headers, such as concrete vee gutters, concrete curbs and construction joints in the asphalt surfacing, in accordance with CALTRANS Section 39. The application rate shall be between 0.02 and 0.10 gallon per square yard as determined by the Engineer.

### 3.05 PAVING

- A. Existing pavement shall be replaced in kind per the specifications of the public agency in authority over the job site.
- B. Asphalt Concrete Paving: Asphalt Concrete shall be applied in lifts to the thickness and in the locations shown in the Drawings.
- C. Cold Mix patching shall be placed over the completed subbase course if paving will be delayed beyond the next day. A minimum of two inches (2") shall be placed and compacted over the whole trench.

### 3.06 SEAL COAT

- A. Following the placement of asphaltic concrete and after sufficient time, the pavement shall be fog sealed at a rate of 0.1 gallons per square yard.

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## SECTION 02770

### EXTRUDED CONCRETE CURB & GUTTER

#### **PART 1 GENERAL**

##### 1.01 SECTION INCLUDES

- A. Construct extruded curb and gutter with weakened plane joints of the form and dimensions shown in the Plans.
- B. The size and configuration of the various components shall be as indicated herein, in the Standard Details, and in the approved Improvement Plans, if any.
- C. All materials and installation shall be in accordance with the standards and specifications of the Solano Irrigation District, latest revisions.

##### 1.02 RELATED SECTIONS

- A. Section 01100 – General Requirements
- B. Section 02300 - Earthwork

##### 1.03 RELATED WORK

- A. Subgrade preparation
- B. Drain inlet curbs and gutter pans

##### 1.04 PAYMENT

- A. Payment for constructing the extruded curb and gutter shall be at the bid unit price per foot for the actual length installed. The price shall include all cost of material, labor, tools, equipment, and all incidentals necessary to complete the curb and gutter as specified.

##### 1.05 SUBMITTALS

- A. Concrete mix design
- B. Admixtures, aggregate gradations and tests.
- C. Cement certificate of compliance with ASTM and CalTrans specifications.

#### **PART 2 MATERIALS**

2.01 GENERAL

- A. All materials shall conform to the State of California Department of Transportation Standard Specifications, latest edition.

2.02 CONCRETE

- A. Concrete for extruded curbs shall have a minimum of 3,500 psi compressive strength at 28 days.

**PART 3 EXECUTION**

3.01 GENERAL

- A. Construction shall conform to the following sections of the State of California Department of Transportation Standard Specifications, latest edition: Section 73, "Concrete Curbs and Sidewalks," Section 90-7, "Curing Concrete," and Section 90-10, "Minor Concrete."

3.02 SURVEY MARKS

- A. Refer to the General Conditions, Section 00700-4.04. Contractor shall coordinate staking requirements with the District. District shall provide benchmarks for establishing grade at convenient locations for the Contractor, but staking at regular intervals shall be the responsibility of the Contractor.

3.03 LIMITS OF EXTRUDED SECTION

- A. The extruded section will be made as close as possible to the drain inlets, but no closer than two (2) feet to allow for construction of the transition as shown in the plans. The extruded section will also be made as close as possible to the designated end points.

3.04 SUBGRADE TOLERANCE

- A. The subgrade beneath the extruded section shall be prepared within  $\pm 0.10$  foot of the design elevation.

/// END OF SECTION

## SECTION 02820

### CHAIN LINK FENCING

#### **PART 1 GENERAL**

##### 1.01 SECTION INCLUDES

- A. The Contractor shall provide all labor, materials and equipment required to furnish and erect chain link fencing.
- B. The size and configuration of the various components shall be as indicated herein, in the Standard Details, and in the approved Improvement Plans, if any.
- C. All materials and installation shall be in accordance with the standards and specifications of the Solano Irrigation District, latest revisions.

##### 1.02 RELATED SECTIONS

- A. Section 01100 – General Requirements
- B. Section 03300 – Cast-in-Place Concrete

##### 1.03 PAYMENT

- A. Measurement will be made of the linear feet of fencing erected.
- B. Payment for fencing will be at the unit price bid therefor in the Bid Schedule. Payment for gates will be at the applicable unit price bid therefor in the Bid Schedule.
- C. Payment shall include all labor, materials and equipment necessary to remove existing fencing indicated on the Drawings, salvage fencing materials, erect and remove temporary fencing, erect the new chain link fencing, and reconnect existing fencing to the new chain link fencing. Concrete used in the embedment of posts will be included in the unit price bid therefor in the Bid Schedule for fencing.

##### 1.04 ALTERNATE DETAILS

- A. Alternate manufacturing details and materials may be submitted by the Contractor for Engineer review and approval.

## **PART 2 MATERIALS**

### **2.01 GENERAL**

- A. All fencing materials and posts shall be galvanized in accordance with ASTM A-123.

### **2.02 CONCRETE**

- A. Concrete for fencing shall be in conformance with the applicable provisions of Section 03300 – Cast-in-Place Concrete. A 5-sack mix shall be used.

### **2.03 FENCE FABRIC**

- A. Chain link fabric shall be 9 gauge carbon steel wire woven in a two inch (2”) mesh, capable of accepting vinyl slats, and galvanized after weaving.
- B. The fence fabric shall be six (6) feet high.

### **2.04 BARBED WIRE**

- A. Barbed wire shall be two strands of galvanized, twisted, 12½ gauge carbon steel wire. Barbs shall be of a four point pattern on four inch centers.

### **2.05 HARDWARE**

- A. Gate hinges shall be ball bearing of the industrial service type, and so designed to permit a 100 degree (100°) swing in each direction from the closed position.
- B. Turnbuckles used for tighteners, or their equivalent, shall have a minimum of six (6) inches of takeup.

## **PART 3 EXECUTION**

### **3.01 GENERAL**

- A. The fencing shall be installed as shown in the Standard Details, the Drawings or specified herein.
- B. Where existing fencing is replaced along open canals, temporary fencing shall be installed per Standard Detail W-52.

### **3.02 POST INSTALLATION**

- A. Fence posts shall be embedded in concrete footings as shown in the Standard Details, and Drawings if any.

- B. Post caps shall be securely fastened.
- C. Rail-and-truss-wire panels shall be used at end posts, and in both directions at all corners, intermediate posts and angle points.
- D. Intermediate posts shall be installed at not more than one thousand foot (1,000') intervals along the fence line, and at grade changes exceeding five percent (5%).

### 3.03 FABRIC INSTALLATION

- A. Tension wires shall be installed at both top and bottom of the fabric.

### 3.04 BARBED WIRE INSTALLATION

- A. Three (3) strands of barbed wire shall be installed above the fabric as shown in the Standard Details.

### 3.05 GATES

- A. Pedestrian and vehicle gates shall be fabricated to the configuration shown in the Standard Details, and Drawings if any.

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## SECTION 03300

### CAST-IN-PLACE CONCRETE

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. The Contractor shall furnish all work and materials, including cement, sand and coarse aggregate, water, admixtures, curing compound, reinforcement, form work and other materials that may form an integral part of the concrete construction.
- B. Reinforced concrete for retaining walls and the like subjected to increased environmental forces or as directed by the Engineer, shall be in accordance to Section 03315 – Structural Concrete.
- C. The size and configuration of the various components shall be as indicated herein, in the Standard Details, and in the approved Improvement Plans, if any.
- D. All materials and installation shall be in accordance with the standards and specifications of the Solano Irrigation District, latest revisions.

##### 1.02 RELATED SECTIONS

- A. Section 01100 – General Requirements
- B. Section 05500 – Miscellaneous Metalwork

##### 1.03 SUBMITTALS

- A. Shop Drawings in accordance with Section 00700.6.11.
- B. Concrete mix design.

##### 1.04 TESTING

- A. Slump test, air entrainment test and compressive test cylinders will be made by the Engineer or as directed by the Engineer, and such tests shall conform to the latest ASTM procedures.

##### 1.05 MEASUREMENT AND PAYMENT

- A. The quantity of concrete will be measured to the neat lines shown on the Drawings, unless otherwise noted. Payment will be made at the unit price bid per cubic yard in the Bid Schedule for the specified reinforced Concrete work. The unit price shall include furnishing and placing all concrete materials, reinforcement, excavation, backfill and water.

- B. The cost of the reinforced concrete for pipe support pads will be included in the cost of piping. Therefore no separate payment for this item will be made in the Bid Schedule for reinforced concrete work.

## **PART 2 MATERIALS**

### **2.01 CEMENT**

- A. All cement shall be Portland Cement, Type II, conforming to ASTM Designation C-150. All cement shall be free of lumps and properly aged.

### **2.02 AGGREGATES**

- A. Fine and coarse aggregates shall conform to the requirements of ASTM C-33. The maximum nominal size of coarse aggregate shall be three quarters of an inch ( $\frac{3}{4}$ ").

### **2.03 WATER**

- A. Water shall be clean and free from oils, acids, salts and other damaging substances. Raw water is not approved.

### **2.04 AIR ENTRAINING AGENT**

- A. The Contractor may use an air entraining agent conforming to the requirements of ASTM Designation C-260 in all concrete. The amount of air entraining agent, if used, shall be such as will affect the entrainment of four to six percent (4% - 6%) of air, by volume of the concrete at the time of discharge from the mixer.

### **2.05 REINFORCEMENT**

- A. Reinforcing steel shall conform to ASTM A-615 Grade 40, or as indicated in the Drawings, for deformed and plain billet steel bars for concrete reinforcement.

### **2.06 MEMBRANE CURING COMPOUND**

- A. Membrane curing compound shall be a non-waxy white pigmented sealing compound conforming to ASTM C-309.

## **PART 3 EXECUTION**

### **3.01 FORMWORK**

- A. Forms shall conform to the shape, line, grade and dimensions of structures as shown on the Drawings.
- B. Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete and shall be maintained rigidly in position. Embedded wire ties for holding forms will not be permitted. Bolts and

rods used for form ties shall be so arranged that when the forms are removed, no metal shall be within 1" of any surface.

- C. Wood forms shall be of sound lumber, free from loose knots or other defects, and of such quality that when treated or coated, there will be no chemical deterioration or discoloration of the formed concrete surface. All form lumber shall be surfaced lumber in narrow and uniform widths closely matched, except that plywood of adequate stiffness shall be used on all surfaces exposed to air or water.
- D. Lumber reused in forms shall be cleaned, repaired and plugged. All nails shall be withdrawn from lumber prior to reuse.
- E. The form sheathing or lining shall be so placed that the joint marks on the concrete surfaces will be in general alignment, both horizontally and vertically. Forms shall be sufficiently tight to prevent loss of mortar from the concrete.
- F. Three-quarter inch ( $\frac{3}{4}$ " ) chamfer strips shall be placed in the corners and at the top-of-wall line of the forms so as to produce beveled edges on permanently exposed concrete edges. Interior angles on such surfaces and edges of formed joints will not require beveling, except where shown on the drawings.
- G. Forms shall be removed as soon as practical after the concrete is placed, but not until the concrete has attained the necessary strength to support all live and dead loads during the construction period. Forms shall be removed in such a manner as to prevent damage to the concrete. Immediately after the forms are removed, all defects in the concrete, including the rod holes, rock pockets, and other unconsolidated areas, shall be repaired by the drypack method, and the total exposed area with sealing compound.
- H. Before the concrete is placed, the forms shall be coated with a non-staining commercial form releasing agent.

### 3.02 TOLERANCES

- A. Variations from level, grade, alignment or plumb for any portion of a structure shall not exceed one-half inch ( $\frac{1}{2}$ " ), unless a more restrictive tolerance is shown on the Drawings.

### 3.03 PLACING REINFORCEMENT

- A. Before concrete reinforcing bars are placed, the surfaces of the bars and the surfaces of any metal supports for reinforcing bars shall be cleaned of heavy flaky rust, loose mill scale, dirt, grease and other foreign substances. Heavy flaky rust that can be removed by rubbing with burlap or equivalent treatment is considered objectionable. After being placed, the reinforcing bars shall be maintained in a clean condition until they are completely embedded in the concrete.
- B. Reinforcing bars shall be accurately placed and secured in position so that they

will not be displaced during the placing of the concrete, and special care shall be exercised to prevent any disturbance of the reinforcing bars in concrete that has already been placed.

- C. Refer to Section 05500 – Miscellaneous Metalwork for requirements for steel embedments and anchor bolts.

### 3.04 CONCRETE PROPORTIONING

- A. The Contractor shall furnish concrete which will develop a minimum compressive strength of 3,000 psi, and shall conform to the basic requirements set forth in these Specifications.
- B. The net water-cement ratio of the concrete (exclusive of water within or absorbed by the aggregates) shall not exceed 0.60 by weight.
- C. A minimum of 5½ sacks of cement per cubic yard shall be used.
- D. The slump shall not exceed 3” for slabs that are horizontal or nearly horizontal, and 4” for other work. The Engineer reserves the right to alter the required slump whenever, in the Engineer’s judgement, the quality of the work will improve.

### 3.05 CONCRETE MIXING

- A. Mixing may be performed at the site of work or by transit-mix methods.
- B. Transit-mixed concrete shall conform to the standard specifications for ready-mixed concrete per ASTM C-94. The total volume of materials mixed per batch shall not exceed the rated capacity of the mixer as determined by the standard requirement of the Associated General Contractors of America.
- C. If a batch mixer is used, the concrete ingredients shall be mixed for not less than one and one half (1½) minutes after all of the ingredients, except for the full amount of water, are in the mixer. The mixing shall be increased if the charging and mixing operations fail to produce a concrete in which the ingredients are consistent and uniform throughout. Water shall be added prior to, during and following the mixer-charging operation. Excessive overmixing, requiring additional water to preserve the concrete consistency, will not be permitted. Any mixer that at any time produces unsatisfactory results shall be repaired or replaced.

### 3.06 CONCRETE PLACING, JOINTING, FINISHING AND CURING

- A. Preparation:
  - 1. In preparation for placing of concrete, all water, sawdust, chips and other construction debris and extraneous matter shall be removed from the interior of the forms.

2. Concrete shall not be placed around any metal reinforcement or embedments until the Engineer has approved the reinforcement or embedments placed within the forms.
3. The forms, subgrade and reinforcement shall be wetted immediately before placement of the concrete.

B. Temperature Limits:

1. The temperature of concrete as mixed and placed shall not be less than 55°F, nor greater than 90°F.
2. If during day or night the ambient temperature falls below, or is predicted to fall below, 40°F, concrete shall be protected from freezing during placement and curing by means of heating of materials or other approved methods, as directed by the Engineer. The concrete mix for cold-weather placement shall be maintained at a minimum temperature of 55°F during placement, and this minimum temperature shall be maintained for the first 72 hours of curing.
3. At all times the maximum temperature of concrete as placed shall be less than 90°F. When the temperature of concrete as placed may be 90°F or higher, as may be reasonably predicted from current temperatures of materials and the likelihood of rises in weather temperatures, the Contractor shall employ effective means, such as precooling aggregates and mixing water, use of ice as a part of the mixing water, shading aggregates, or placing at night, as necessary, to maintain the temperature of concrete, as placed, below 90°F.

C. Placing: The concrete in each integral part of the structure shall be placed continuously. The Contractor shall not be allowed to commence concrete placement in any integral part of the structure unless the inspected and approved forms, reinforcement, embedments and other materials on hand are sufficient to allow completing the part without interruption in the placing of the concrete. The concrete shall be placed as nearly as possible to its final position by means that avoid segregation of the materials and displacement of the reinforcement. Concrete shall not be permitted to fall from a height greater than six feet (6') without the use of adjustable length pipes or "elephant trunks."

D. Compaction: Concrete during and immediately after placing, shall be thoroughly compacted. The compaction shall be done with mechanical vibrators capable of transmitting vibration to the concrete at frequencies of not less than 4,000 cycles per minute. The location, manner and duration of the application of the vibrators shall be such as to secure maximum consolidation of the concrete. The vibrators shall not be attached to or held against the forms or the reinforcing steel.

E. Joints:

1. Construction Joints: Construction joints placed in concrete structures to

facilitate construction must be approved by the Engineer. Bond is required at all construction joints. The surface of all joints shall be clean and damp when covered with fresh concrete or mortar. Cleaning shall consist of removal of all laitance, loose or defective concrete, coatings, sand, and other foreign material from the surface of the joint and exposed reinforcing steel. Mortar for bonding of joints shall be the same as that in the concrete with the coarse aggregate omitted. The mortar bond shall be approximately one half inch (1/2") thick and worked into the joint surface.

2. Contraction Joints: These joints are placed in structures or slabs to provide for movement between units, and shall have no bond across the joint. Units shall be separated by joint filler where indicated on the Drawings.

F. Finishing: All horizontal surfaces on structures will have a light broom finish.

G. Curing: Reinforced concrete shall be cured by membrane curing. Sealing compound shall be applied to the concrete surfaces by spraying in one coat to provide a continuous, uniform membrane over all areas.

/// END OF SECTION

## SECTION 03310

### CONCRETE PIPE STRUCTURES

#### **PART 1 GENERAL**

##### 1.01 SECTION INCLUDES

- A. Where shown on the Drawings, the Contractor shall construct concrete pipe structures in accordance with these specifications. Concrete pipe structures shall include air vents, metering wells, risers, turnout stands, pump stands, outlet stands, line valve stands, flow meter stands, and float valve stands.
- B. The size and configuration of the various components shall be as indicated herein, in the Standard Details, and in the approved Improvement Plans, if any.
- C. All materials and installation shall be in accordance with the standards and specifications of the Solano Irrigation District, latest revisions.

##### 1.02 RELATED SECTIONS

- A. Section 01100 – General Requirements
- B. Section 02300 – Earthwork
- C. Section 03300 – Cast-in-Place Concrete
- D. Section 05500 – Miscellaneous Metalwork

##### 1.03 PAYMENT

- A. Concrete pipe structures will be paid for at the unit price bid per structure in the Bid Schedule. The unit price shall include furnishing and installing all materials, labor, equipment, excavation and backfill necessary to construct the structures per the Drawings and Standard Details.

#### **PART 2 MATERIALS**

##### 2.01 CONCRETE PIPE

- A. Concrete pipe used in air vents, risers and metering wells up to 24 inches in diameter shall conform to ASTM Designation C 118.
- B. Concrete pipe used in stands 30 inches in diameter and larger shall conform to ASTM Designation C 76, and be centrifugally spun pipe.

## 2.02 BANDING MORTAR

- A. Mortar for jointing tongue-and-groove concrete pipe shall be composed of not less than one part Portland cement to two (1:2) parts, by weight, of clean, well-graded sand which will pass a one eighth inch (1/8") screen. An admixture may be used, not exceeding one of the following percentages by volume of cement: Hydrated lime, five percent (5%); fire clay, diatomaceous earth, or other suitable inert material, ten percent (10%).
- B. Consistency of the laying mortar shall be such as to adhere to the ends of the pipe while being laid, and easily squeezed out of the joint when the pipe sections are placed together. Any mortar that has become so stiff that retempering is necessary shall be wasted.

## PART 3 EXECUTION

### 3.01 AIR VENTS AND RISERS

Air vents and risers shall be located along the pipelines and at pipe structures where shown on the Drawings and will be constructed in accordance with the drawings. The opening in the section of pipe to which the vent or riser will be attached shall be formed prior to placing the section of pipe in the line. If the opening is broken out in the field, care shall be taken so as to not damage the pipe beyond the required opening for the vent pipe or risers. No cracked, spoiled, or broken pipe will be permitted in the pipeline. Jointing and banding shall conform to the applicable provisions of subsection 3.04. After the vent pipe or riser has been mortared into place, Kraft paper shall be placed firmly over and about the fresh mortar. Where shown on the drawings, air vents shall be furnished with vent covers constructed per Section 05500 – Miscellaneous Metalwork.

### 3.02 METERING WELLS

Metering wells shall be located on the concrete pipes where shown on the Drawings and will be constructed in accordance with the details shown. Jointing and banding shall conform to the applicable provisions of subsection 3.04. Covers shall be furnished for metering wells.

### 3.03 CONCRETE PIPE STANDS

Concrete pipe turnout stands, pump turnout stands, outlet stands, line valve stands, flow meter stands, and float valve stands shall be constructed to the lines and grades shown on the Drawings. Concrete, pipe, and other materials incorporated in stands shall be as shown on the Drawings. Where stands are comprised of more than one joint of pipe, banding shall be in accordance with the applicable portions of subsection 3.04. The Contractor may substitute rubber gasketed bell and spigot pipe for mortar joint pipe, at no additional cost to the District.

### 3.04 MORTAR JOINT BANDING

The external surface of the pipe at the joint shall be cleaned and wetted to insure proper bond of the banding mortar with the concrete of the pipe. Care shall be taken to make a union between the band and the mortar which was placed under the joint before the pipe sections were abutted. The band shall be not less than three-eighth inch (3/8") in thickness at the joint and shall be approximately four inches (4") in width, overlapping the abutting ends of the pipe sections approximately two inches (2"). The edges of the band must adhere to the pipe surface to prevent peeling and shall be finished in a workmanlike manner. Upon completion of the band, it shall be covered immediately with a strip of wetted Kraft paper four inches (4") in width.

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## SECTION 03315

### STRUCTURAL CONCRETE

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. The Contractor shall furnish all work and materials, including cement, sand and coarse aggregate, water, admixtures, curing compound, reinforcement, form work and other materials that may form an integral part of the concrete construction.

##### 1.02 RELATED SECTIONS

- A. Section 01100 – General Requirements

##### 1.03 SUBMITTALS

- A. Shop fabrication drawings
- B. Proposed Dewatering Plan

##### 1.04 TESTING

- A. Concrete: Slump test, air entrainment test and compressive test cylinders shall conform to the latest ASTM procedures.
- B. Cohesive Materials: the density of the backfill shall be not less than ninety percent (90%) of the maximum dry density as determined by Test Method ASTM D-1557.
- C. Non-cohesive Materials: the density of the backfill shall be not less than seventy percent (70%) of the relative dry density as determined by Test Method ASTM D-4253. Density requirements vary depending on the type of backfill being compacted.
- D. Testing will be performed by an outside agency, at the District's expense.

##### 1.05 MEASUREMENT AND PAYMENT

- A. The quantity of concrete will be measured to the neat lines shown on the Drawings, unless otherwise noted. Payment will be made at the unit price bid per cubic yard in the Bid Schedule for the specified reinforced concrete work. In measuring for payment, the volume of openings, which are individually larger than one hundred square inches (100 sq. in.) in cross section, will be deducted. The unit price shall include furnishing and placing all concrete materials, rock, reinforcement, bearing pads, water, gravel, excavation and backfill, and furnishing a concrete washout area.

## 1.06 REFERENCES

- A. This project shall conform to all requirements of ACI 301-05 – Specifications for Structural Concrete published by the American Concrete Institute, Farmington Hills, Michigan ([www.concrete.org](http://www.concrete.org)) except as modified by these Contract Documents.
- B. CASQA BMP Handbook – Construction published by the California Stormwater Quality Association ([www.casqa.org](http://www.casqa.org)).

## PART 2 MATERIALS

### 2.01 CEMENT

- A. All cement shall be Portland Cement, Type II, conforming to ASTM Designation C-150. All cement shall be free of lumps and properly aged.

### 2.02 AGGREGATES

- A. Fine and coarse aggregates shall conform to the requirements of ASTM C-33. The maximum nominal size of coarse aggregate shall be three quarters of an inch ( $\frac{3}{4}$ ").

### 2.03 WATER

- A. Water shall be clean and free from oils, acids, salts and other damaging substances.

### 2.04 AIR ENTRAINING AGENT

- A. The Contractor may use an air entraining agent conforming to the requirements of ASTM Designation C-260 in all concrete. The amount of air entraining agent, if used, shall be such as will affect the entrainment of four to six percent (4% - 6%) of air, by volume of the concrete at the time of discharge from the mixer.

### 2.05 REINFORCEMENT

- A. Reinforcing steel shall conform to ASTM A-615 Grade 60 or ASTM 706 Grade 60 for deformed and plain billet steel bars for concrete reinforcement.

### 2.06 MEMBRANE CURING COMPOUND

- A. Membrane curing compound shall be a non-waxy white pigmented sealing compound conforming to ASTM C-309.

## PART 3 EXECUTION

### 3.01 WATER AND AIR POLLUTION REQUIREMENTS

- A. The Contractor shall implement the following measures to minimize the potential impacts on the water quality of the District canals, District and roadside drainage ditches.
  - 1. All Contractor fuels, oils greases, and other petroleum products shall be stored away from the canals and ditches so that is there is any leakage it will not flow into the waterways.
  - 2. All Contractor vehicles and equipment shall undergo periodic inspection and maintenance to minimize the potential of leaks or spills of oils, grease, or hydraulic fluids into the waterways.
  - 3. The excavation of soils shall be stockpiled in suitable locations to prevent erosion and sedimentation from flowing into the waterways.
  
- B. The Contractor shall implement the following measures to minimize potential impacts on air quality.
  - 1. Stockpiled soils shall be sprayed with water to prevent blowing dust.
  - 2. Unpaved graded and excavated areas within the proposed project construction area shall be appropriately sprayed with water each day to minimize blowing dust.
  - 3. To minimize the deposition of soil on the County roads, the paved areas at all entry and exit sites shall be swept, scraped and/or washed, as appropriate, to remove silt and dirt accumulated from construction activities.
    - a. At no time shall large clods or quantities of dirt be left on the paved roadways. At the time of notification, the Contractor shall immediately remove the debris from the roadways.

### 3.02 SITE PREPARATION

- A. Site preparation includes clearing, grubbing, hauling and disposing of cleared material, installation and removal of temporary fencing, and all work incidental thereto.
  
- B. Existing improvements such as pavement, walls, buildings and hedges will be removed as shown on the Drawings or directed by the Engineer.
  
- C. All areas of earthwork shall be cleared of trees, brush, rubbish, concrete and other objectionable material, where required, in the judgment of the Engineer. The soil under all structures shall be cleared of all stumps, roots and objectionable organic matter. Blasting shall not be permitted.

- D. All cleared and grubbed material shall become the property of the Contractor and shall be removed from the site of the work before the date of completion, or otherwise disposed of as approved by the Engineer.
- E. Approval by the District of any of the Contractor's operations or methods when clearing, grubbing and disposing of the materials shall not relieve the Contractor of its responsibilities provided for in the General Conditions Section 00700.
- F. Temporary fencing for livestock or human safety shall be installed, maintained, and removed by the Contractor as shown on the Drawings or as directed by the Engineer.
- G. The payment for site preparation will be included in the applicable unit prices in the Bid Schedule for excavation, unless separate line items are listed in the Bid Schedule.

### 3.03 EXCAVATION

- A. The bottom and side slopes of excavation upon or against which concrete is to be placed shall be finished accurately to the dimensions shown in the Drawings or as prescribed by the Engineer.
- B. If, at any point, material is excavated beyond the neat lines required to receive the structure or the natural foundation is disturbed or loosened during the excavation process, the foundation for the structure shall be brought back to grade and consolidated in a manner satisfactory to the Engineer.
- C. Excess material from excavation may be stockpiled and/or disposed in designated areas in the vicinity of the proposed work as shown on the Drawings or as directed by the Engineer.
- D. All excess material shall be disposed of as directed by the Engineer and graded smooth to blend in with the existing ground surface contours.
- E. The Contractor's attention is called to **Section 00700.6.10** (Safety and Protection).

### 3.04 BACKFILL

- A. The Contractor shall place backfill about structures to the lines shown on the Drawings or prescribed by the Engineer.
- B. Backfill materials shall be obtained from materials removed in the excavation for the structures, or sources approved by the Engineer.
- C. Backfill shall be compacted up to natural ground, unless otherwise shown on the Drawings or directed by the Engineer.

- D. Backfill may be placed against concrete structures after the concrete has reached a compressive strength of 4,000 psi.
1. In the event the Contractor desires to undertake the backfill of the structure before it has reached the recommended compressive strength, he may do so provided he provides temporary strutting and bracing within or about the structure as a protection against possible damage.
  2. These struts and braces shall be left in place until the concrete has reached the compressive strength of 4,000 psi.
  3. Before and struts or braces are placed, the Contractor shall submit to the District Engineer for approval, a detailed proposal outlining the Contractor's plan, method of placement, and materials required to complete the task.
  4. No compensation or payment will be made to the Contractor for these additional expenses.

### 3.05 COMPACTION

- A. Refer to subsection 1.04 for required compaction test methods and requirements.
- B. Compacting backfill is defined as the process of placing earth materials or approved backfill material in six inch (6") layers equally about the structure, moistening the material uniformly, and compacting each layer with hand or mechanical tamping or vibrator equipment to the required density, as determined by laboratory test.

### 3.06 FORMWORK

- A. Forms shall conform to the shape, line, grade and dimensions of structures as shown on the Drawings.
- B. Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete and shall be maintained rigidly in position. Embedded wire ties for holding forms will not be permitted. Bolts and rods used for form ties shall be so arranged that when the forms are removed, no metal shall be within 1" of any surface.
- C. Wood forms shall be of sound lumber, free from loose knots or other defects, and of such quality that when treated or coated, there will be no chemical deterioration or discoloration of the formed concrete surface. All form lumber shall be surfaced lumber in narrow and uniform widths closely matched, except that plywood of adequate stiffness shall be used on all surfaces exposed to air or water.

- D. Lumber reused in forms shall be cleaned, repaired and plugged. All nails shall be withdrawn from lumber prior to reuse.
- E. The form sheathing or lining shall be so placed that the joint marks on the concrete surfaces will be in general alignment, both horizontally and vertically. Forms shall be sufficiently tight to prevent loss of mortar from the concrete. Three-quarter inch ( $\frac{3}{4}$ " ) chamfer strips shall be placed in the corners and at the top-of-wall line of the forms so as to produce beveled edges on permanently exposed concrete edges. Interior angles on such surfaces and edges of formed joints will not require beveling, except where shown on the drawings.
- F. Before the formwork is placed, they shall be coated with non-staining commercially manufactured formwork release agent that prevents formwork absorption of moisture and bonding with concrete.
  - 1. The release agent shall not come in contact with the reinforcing steel or hardened concrete against which fresh concrete is to be placed.
- G. Forms shall be removed as soon as practical after the concrete is placed, but not until the concrete has attained the necessary strength to support all live and dead loads during the construction period. Forms shall be removed in such a manner as to prevent damage to the concrete. Immediately after the forms are removed, all defects in the concrete, including the rod holes, rock pockets, and other unconsolidated areas, shall be repaired by the drypack method, and the total exposed area coated with a non-waxy white pigmented sealing compound.
  - 1. The foundation formwork and concrete shall remain in place and cure a minimum of 3 days before work can commence on top of the foundation, verified by cylinder testing.
  - 2. Areas with subsequent concrete placement, the structure formwork and concrete shall remain in place and cure a minimum of 14 days before the forms may be removed and work to continue around the structure, verified by cylinder testing. See subsection 3.04.
  - 3. All areas that do not have subsequent concrete placement shall have the formwork remain in place for the required 28 day period, unless approved in writing by the District Engineer.

### 3.07 TOLERANCES

- A. Variations from level, grade, alignment or plumb for any portion of a structure shall not exceed one-half inch ( $\frac{1}{2}$ " ), unless a more restrictive tolerance is shown on the Drawings.

### 3.08 PLACING REINFORCEMENT

- A. Before concrete reinforcing bars are placed, the surfaces of the bars and the

surfaces of any metal supports for reinforcing bars shall be cleaned of heavy flaky rust, loose mill scale, dirt, grease and other foreign substances. Heavy flaky rust that can be removed by rubbing with burlap or equivalent treatment is considered objectionable. After being placed, the reinforcing bars shall be maintained in a clean condition until they are completely embedded in the concrete.

- B. Reinforcing bars shall be accurately placed and secured in position so that they will not be displaced during the placing of the concrete, and special care shall be exercised to prevent any disturbance of the reinforcing bars in concrete that has already been placed.
- C. Unless installation by use of grouting recesses or use of expansion anchors is approved by the Engineer, anchor bolts and the metalwork to be embedded in the concrete shall be installed before the concrete is placed, and shall be supported firmly and accurately in position while the concrete is being placed.

### 3.09 CONCRETE PROPORTIONING

- A. The Contractor shall furnish concrete which will develop a minimum compressive strength of 4,000 psi, and shall conform to the basic requirements set forth in these Specifications.
- B. The net water-cement ratio of the concrete (exclusive of water within or absorbed by the aggregates) shall not exceed 0.53 by weight.
- C. A minimum of 6 sacks of cement per cubic yard shall be used.
- D. The slump shall not exceed 3" for slabs that are horizontal or nearly horizontal, and 4" for other work. The Engineer reserves the right to alter the required slump whenever, in the Engineer's judgement, the quality of the work will improve.

### 3.10 CONCRETE MIXING

- A. No mixing may be performed at the site of work but shall be performed by transit-mix methods.
- B. Transit-mixed concrete shall conform to the standard specifications for ready-mixed concrete per ASTM C-94. The total volume of materials mixed per batch shall not exceed the rated capacity of the mixer as determined by the standard requirement of the Associated General Contractors of America.
- C. The concrete ingredients shall be mixed for not less than one and one half (1½) minutes after all of the ingredients, except for the full amount of water, are in the mixer.
  - 1. The mixing shall be increased if the charging and mixing operations fail to produce a concrete in which the ingredients are consistent and uniform throughout.

2. Water shall be added prior to, during and following the mixer-charging operation.
3. Excessive overmixing, requiring additional water to preserve the concrete consistency, will not be permitted.
4. Any mixer that at any time produces unsatisfactory results shall be repaired or replaced.

### 3.11 CONCRETE WASHOUT AREA

- A. The Contractor shall establish at the project site a specific location or locations for all ready mix concrete trucks to washout after completing their delivery.
- B. All washwater and any remaining concrete debris shall only be disposed of at the specified locations.
- C. No washwater or leftover concrete shall be spoiled into the on-site or nearby waterways.
- D. The Contractor will be responsible for removing all washwater debris from the washout location(s) at the conclusion of the project, at the Contractor's expense.

### 3.12 CONCRETE PLACING, JOINTING, FINISHING AND CURING

- A. Preparation:
  1. In preparation for placing of concrete, all water, sawdust, chips and other construction debris and extraneous matter shall be removed from the interior of the forms.
  2. Concrete shall not be placed around any metal reinforcement or embedments until the Engineer has approved the reinforcement or embedments placed within the forms.
  3. The forms, subgrade and reinforcement shall be wetted immediately before placement of the concrete.
- B. Temperature Limits:
  1. The temperature of concrete as mixed and placed shall not be less than 55°F, or greater than 90°F.
  2. If during day or night the ambient temperature falls below, or is predicted to fall below, 40°F, concrete shall be protected from freezing during placement and curing by means of heating of materials or other approved methods, as directed by the Engineer. The concrete mix for cold-weather

placement shall be maintained at a minimum temperature of 55°F during placement, and this minimum temperature shall be maintained for the first 72 hours of curing.

3. At all times the maximum temperature of concrete as placed shall be less than 90°F. When the temperature of concrete as placed may be 90°F or higher, as may be reasonably predicted from current temperatures of materials and the likelihood of rises in weather temperatures, the Contractor shall employ effective means, such as precooling aggregates and mixing water, use of ice as a part of the mixing water, shading aggregates, or placing at night, as necessary, to maintain the temperature of concrete, as placed, below 90°F.
- C. Placing: The concrete in each integral part of the structure shall be placed continuously. The Contractor shall not be allowed to commence concrete placement in any integral part of the structure unless the inspected and approved forms, reinforcement, embedments and other materials on hand are sufficient to allow completing the part without interruption in the placing of the concrete. The concrete shall be placed as nearly as possible to its final position by means that avoid segregation of the materials and displacement of the reinforcement. Concrete shall not be permitted to fall from a height greater than six feet (6') without the use of adjustable length pipes or "elephant trunks."
- D. Compaction: Concrete during and immediately after placing, shall be thoroughly compacted. The compaction shall be done with mechanical vibrators capable of transmitting vibration to the concrete at frequencies of not less than 4,000 cycles per minute. The location, manner and duration of the application of the vibrators shall be such as to secure maximum consolidation of the concrete. The vibrators shall not be attached to or held against the forms or the reinforcing steel.
- E. Joints:
1. Construction Joints: Construction joints placed in concrete structures to facilitate construction must be approved by the Engineer. Bond is required at all construction joints. The surface of all joints shall be clean and damp when covered with fresh concrete or mortar. Cleaning shall consist of removal of all laitance, loose or defective concrete, coatings, sand, and other foreign material from the surface of the joint and exposed reinforcing steel. Mortar for bonding of joints shall be the same as that in the concrete with the coarse aggregate omitted. The mortar bond shall be approximately one half inch (1/2") thick and worked into the joint surface.
  2. Contraction Joints: These joints are placed in structures or slabs to provide for movement between units, and shall have no bond across the joint. Units shall be separated by joint filler where indicated on the Drawings.
- F. Finishing: All horizontal surfaces on structures will have a light broom finish.

- G. Curing: Reinforced concrete shall be cured by membrane curing. Sealing compound shall be applied to the exposed concrete surfaces by spraying in one coat to provide a continuous, uniform membrane over all areas.

/// END OF SECTION

## SECTION 04820

### CONCRETE MASONRY FENCING

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. The Contractor shall provide all labor, materials and equipment required to furnish and erect the concrete masonry fencing. The fencing shall be installed as shown on the Drawings or specified herein.
- B. The size and configuration of the various components shall be as indicated herein, in the Standard Details, and in the approved Improvement Plans, if any.
- C. All materials and installation shall be in accordance with the standards and specifications of the Solano Irrigation District, latest revisions.

##### 1.02 RELATED SECTIONS

- A. Section 01100 – General Requirements

##### 1.03 SUBMITTALS

- A. The concrete masonry fencing shall be designed by a civil engineer registered in the State of California, and design calculations and drawings shall be submitted to the Engineer for approval. The following conditions and factors shall be used in the design calculations:
  - 1. Seismic Loading: Zone 4, Importance Factor = 1.0
  - 2. Wind Loading: Exposure Condition C, Basic wind Speed = 70 mph, Importance Factor = 1.0.
- B. The Contractor shall submit to the District three (3) copies of color samples of the masonry fencing units for selection by the District.

##### 1.04 CONTRACTOR'S INSPECTION REQUIREMENTS

- A. The Contractor shall, prior to construction, satisfy himself as to the following job site specifics:
  - 1. The location of the wall relative to existing residential fences.
  - 2. The location of power and water available to the Contractor at the project site.

## 1.05 PAYMENT

- A. Masonry fencing will be paid for at the applicable unit price per linear foot of masonry fencing being erected. Concrete, grout and reinforcing steel used in the construction of the fence will be included in the unit price bid for the masonry fence.

## **PART 2 MATERIALS**

### 2.01 MASONRY FENCING SYSTEM

- A. The fencing shall be designed and installed in accordance with the Basalite "Proto II" Post Tensioned Masonry Fencing System or approved equal.

### 2.02 MASONRY FENCING UNITS

- A. Masonry fencing units shall be made of a durable high-strength, lightweight concrete meeting the requirements of ASTM C-90.

### 2.03 MORTAR

- A. Concrete mortar shall be in accordance with ASTM C-270.

### 2.04 GROUT

- A. Grout shall be as shown on the Drawings.

### 2.05 REINFORCEMENT

- A. Reinforcement shall be as required by the approved design.

## **PART 3 EXECUTION**

### 3.01 ERECTION

- A. The masonry fence shall be erected to the heights shown in the Drawings.

### 3.02 REINFORCEMENT

- A. Reinforcement shall be installed as required by the approved design. Reinforced cells shall be filled with grout as required by the approved design.

/// END OF SECTION

## SECTION 05500

### MISCELLANEOUS METALWORK

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. The Contractor shall furnish and install the following items of metalwork, as miscellaneous metalwork, as shown on the drawings or otherwise directed:
  - 1. Weir board guides
  - 2. Galvanized pipe handrails
  - 3. Structural steel shapes
  - 4. Checker plate
  - 5. Grating
  - 6. Anchor bolts
  - 7. Air vent and/or air release valve covers
  - 8. Turnout stand covers
  - 9. Concrete box structure covers
  - 10. Siphon or turnout structure inlet trash screens
- B. The size and configuration of the various components shall be as indicated herein, in the Standard Details, and in the approved Improvement Plans, if any.
- C. All materials and installation shall be in accordance with the standards and specifications of the Solano Irrigation District, latest revisions.

##### 1.02 RELATED SECTIONS

- A. Section 01100 – General Requirements
- B. Section 03300 – Cast-in-Place Concrete

##### 1.03 DESIGN REQUIREMENTS

- A. Checker plate and grating for landings shall be sufficient to meet all current Uniform Building Code and Cal/OSHA load and design requirements.

##### 1.04 CONTRACTOR'S INSPECTION REQUIREMENTS

- A. The Contractor shall, prior to construction, be satisfied as to the dimensions of the concrete structure on or in which the miscellaneous metalwork shall be placed.

##### 1.05 PAYMENT

- A. Miscellaneous metal work will be paid for at the unit prices bid per pound.

## **PART 2 MATERIALS**

### **2.01 STEEL**

- A. Structural steel shapes, plates, bars, rods, and straps shall conform to the specification of ASTM Designation A7. All other materials for miscellaneous metalwork not specifically covered by the ASTM specification shall be of good commercial quality and approved by the Engineer.

### **2.02 GALVANIZING**

- A. All metalwork called out to be galvanized shall be galvanized in accordance with ASTM Designation A-123 or A-153.

## **PART 3 EXECUTION**

### **3.01 EMBEDMENTS**

- A. Unless installation by use of grouting recesses or use of expansion anchors is approved, anchor bolts and the metalwork to be embedded in concrete shall be installed before the concrete is placed and shall be supported firmly and accurately in position while the concrete is being placed.

### **3.02 GRATING**

- A. Grating shall be installed so that it contacts as much of its supports as is practical, yet may be easily removed for maintenance. It shall lay flat on its supports without rocking. Openings in grating for projecting objects (such as valve stems) shall be as small as practical and minimize the safety hazards per the Engineer.

/// END OF SECTION

## SECTION 05530

### CANAL TRASH SCREENS AND LIFENETS

#### **PART 1 GENERAL**

##### 1.01 SECTION INCLUDES

- A. Fabrication and installation of trash screens, which are gratings installed at the inlets of culverts, siphons and pipelines.
- B. Fabrication and installation of life nets, which are installed upstream of the inlets of culverts, siphons and pipelines. Life nets are galvanized stock fencing supported by galvanized cable secured at canal banks.
- C. The size and configuration of the various components shall be as indicated herein, in the Standard Details, and in the approved Improvement Plans, if any.
- D. All materials and installation shall be in accordance with the standards and specifications of the Solano Irrigation District, latest revisions.

##### 1.02 RELATED SECTION

- A. Section 01100 – General Requirements

##### 1.03 PAYMENT

- A. Canal trash screens and life nets shall be paid for at the lump sum price bid therefore in the Bid Schedule.

#### **PART 2 MATERIALS**

##### 2.01 TRASH SCREENS

- A. Trash screen members shall be structural steel, arc welded members, tailor-made to fit the individual structures. The vertical members shall be 3/8" x 4" flat bar. The surround shall be 4" x 6" x 3/8" angle.

##### 2.02 LIFENETS

- A. Stock fence wire shall be 32 inches high with 10 ga. top and bottom wires, 12½ ga. mesh wires, total eight horizontal wires. Stays shall be 12½ ga. spaced 6 in. on center. All wires shall be galvanized.
- B. Cable shall be 3/8 in. diameter, 6x19 galvanized improved plow steel, with hemp center or approved equal.

C. Steel posts to anchor lifenets shall be 2" Schedule 40 galvanized steel pipe.

D. Lifenet marker posts shall be redwood or pressure-treated 4" x 4" posts.

### **PART 3 EXECUTION**

#### **3.01 TRASH SCREEN CONSTRUCTION**

A. The entire frame shall be fabricated to the satisfaction of the Engineer according to the Standard Details and plans, if any, and such that it may be placed and removed without necessity of foundation blocks or stationary anchors.

#### **3.02 LIFENET CONSTRUCTION**

A. Steel anchor posts shall be buried three feet in compacted earth backfill. Posts shall protrude 2 feet above the bank.

B. Cable shall be belayed with double turn around posts and secured with two galvanized cable clamps on each end. Turn buckles may be required to provide the necessary tension in the cable to support the lifenet without excessive sag, as directed by the Engineer. Stock fence shall be secured to cable with galvanized pulleys, chain and safety snap hooks at 4 ft. centers.

C. Marker posts shall be set next to the anchor posts, embedded two feet in compacted earth backfill, protrude 2 feet above the bank, and be painted yellow.

/// END OF SECTION

## SECTION 11210

### MOTOR DRIVEN PUMPING UNITS

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. If so specified in the Bidding Documents and the Supplementary Requirements, the work covered in this specification consists of furnishing and delivering to the Solano Irrigation District, the items of equipment listed on the data sheets complete with all accessories as specified herein.
- B. If so specified in the Bidding Documents and the Supplementary Requirements, the Contractor shall furnish, install and make ready for service vertical turbine or centrifugal pumping units.

##### 1.02 RELATED SECTIONS

- A. Section 01100 – General Requirements
- B. Section 13400 – Supervisory Control and Data Acquisition
- C. Section 16010 – Basic Electrical Methods
- D. Section 16100 – Wiring Methods
- E. Section 16400 – Distribution and Grounding

##### 1.03 REFERENCES

- A. AWWA E-101 – Standard for Vertical Turbine Pumps – Line Shaft and Submersible Types, latest revision.
- B. AWWA E-103 – Standard for Horizontal and Vertical Line-Shaft Pumps, latest revision.

##### 1.04 SUBMITTALS

- A. The Contractor shall furnish three (3) sets of prints and one electronic copy of the pump curves and assembly drawings with their proposal. The pump curves or assembly drawings shall specify the pump make, type or model number, and if applicable, the number of stages.
- B. Within ten (10) days after receiving the Notice to Proceed with the work, or as specified within the Contract, the Contractor shall submit to the Engineer three (3) sets of assembly drawings and sufficient construction drawings to demonstrate

fully that the equipment to be furnished will conform to these Specifications and the data submitted with the Contractor's Proposal. Review by the Engineer of the Contractor's drawings shall not relieve the Contractor of any part of its responsibilities to meet all of the requirements of these Specifications.

- C. Motor manufacturers shall furnish the following certified motor data from representative sample motors:
  - 1. Nominal horsepower and revolutions per minute
  - 2. Efficiencies at 100%, 75% and 50% rated load.
  - 3. Power factor at 100%, 75% and 50% rated load.
  - 4. Values for torque in lb/ft at rated load, pump motors only.
  - 5. Full load current at rated voltage.
  - 6. Locked rotor current values.
  - 7. Motor make and frame number.
  
- D. The Contractor shall also furnish three (3) sets of prints and one electronic copy of complete detailed instructions for the installation, operation, maintenance and repair of each pump.

#### 1.05 GUARANTY

- A. The Contractor shall guarantee the pumping unit and appurtenant apparatus against defects which are disclosed within two years after the equipment is successfully placed in operation. Upon notice to the Contractor by the District of needed repairs, the Contractor shall undertake such repairs within forty-eight (48) hours. If, after installation, the operation of the equipment fails to conform to these specifications or information accompanying the Proposal, or both, and prove unsatisfactory to the District, the District shall have the right to operate such equipment without injury to the District until it can be taken out of service for correction of defects, errors or omissions, or for replacement of unsatisfactory equipment in whole or in part.

#### 1.06 MEASUREMENT & PAYMENT

- A. Payment for furnishing and installing pumping units with the pertinent apparatus will be made at the lump sum price bid therefore in the Bid Schedule. This price shall include the cost of furnishing and installing all pumps and motors, tests, taxes, and all work and material necessary to furnish and install the pumping units in an operational condition.

### **PART 2 MATERIALS**

#### 2.01 GENERAL

- A. It being recognized that there will be substantial differences in the design of pumping units of the size and type desired, these specifications have been limited to controlling requirements.

- B. Liberal factors of safety shall be used throughout the designs and especially in the design of all parts subject to alternating stresses, strains and forces for Seismic Zone 4.
- C. All pumps and motors shall conform to the Pump and Motor Data Sheets, the information accompanying the Contractor's Proposal, these Specifications and the Drawings.
- D. The Engineer shall have the right to require the Contractor to make any changes in the equipment design which may be necessary to make the equipment so conform without additional cost to the District.
- E. The pumping units shall be furnished with all accessories required to secure the equipment rigidly in position and necessary to provide efficient operation of the system.
- F. The pumping units shall use premium efficiency equipment with an overall pumping plant efficiency not less than 70%.
- G. The pumping units shall be suitable for outdoor operation in direct exposure to the elements.
- H. The pumps shall withstand a hydrostatic pressure equal to one and one-half times the shutoff head or twice the operating head at the specified capacity, whichever is greater. The Contractor shall have conducted shop running tests and shall conduct field tests to determine the characteristics.
- I. All equipment shall be new and of the manufacturer's latest model. All materials used in the manufacture of the pumping units shall be new and of the highest standard commercial quality as normally used for this type of equipment, considering strength, ductility, durability, best engineering practice, and the purpose for which the equipment is to be used.
- J. All bolts, nuts, screws, rivets, threads, pipe gages and measurements shall conform to United States and American Standards. All parts shall be made accurately to standard gage where possible so as to facilitate replacement and repair.
- K. All work shall be performed and completed in a thorough, workmanlike manner and shall follow the best modern practice in the manufacture of high-grade equipment of the type to be furnished notwithstanding any omissions from these Specifications. All work shall be performed by mechanics skilled in their various trades.

## 2.02 CENTRIFUGAL PUMPS

- A. The centrifugal pumping unit shall include vertically and horizontally mounted

centrifugal pumping units. The pump shall be driven directly by a motor connected to the pump casing in such a manner as to form an integral part of the pumping unit. In general, the pumping unit shall conform to the provisions of AWWA E103.

- B. The pump and motor shall have an integral drive shaft. The shaft shall ensure positive alignment between the motor and the impeller. The pump suction and discharge shall be on the same centerline. The Contractor shall furnish to the District these units for installation where shown in the Drawings. The pumping unit shall be suitable for outdoor operation in direct exposure to the elements.
- C. The pump shall be as manufactured by Paco, Peerless Pump Hydrodynamics Division, Ingersoll-Dresser, Space-Miser by Pacific Pumping Company, or approved equal.
- D. The pumps shall be single stage with a volute casing. The casing shall have a replaceable wear ring.
- E. Impellers shall be of a material that will not be adversely affected by the water quality and shall be the single suction enclosed type. Impellers shall be cast in one piece and shall be finished smooth. The impellers shall be statically and dynamically balanced. Impellers shall be keyed or threaded to the drive shaft and secured by locking devices. The impellers shall be capable of being easily removed from the shaft for maintenance.
- F. The pump shall be provided with a mechanical shaft seal and shall be properly vented to the suction side. The shaft shall be of one piece and of sufficient cross-section to eliminate vibration and damaging deflections. The shaft shall be stainless steel.
- G. The pump and motor shall be free of vibration.

### 2.03 VERTICAL MIXED FLOW AND PROPELLER PUMPS

- A. Each pump shall be a vertical-shaft mixed flow or propeller type pump, constant speed, direct connected, electric motor driven, single or multi-stage bowl assembly designed for continuous duty high efficiency water plant service.
- B. The pump shall be driven directly by a motor mounted on the discharge head. In general, the pumping unit shall conform to the provisions of AWWA E101.
- C. The pump shall be manufactured by one manufacturer. The pump shall be as manufactured by the Byron-Jackson Company, Johnston Pump Company, Peerless Pump Hydrodynamics Division of the FMC Corporation, Peabody Floway, Inc., or by an approved equal.
- D. The pump discharge head shall have a suitable base of high grade cast iron or steel for mounting the motor with an integral discharge nozzle adaptable to a

Dresser Coupling Type 38 or equipped with a Class D ring flange, as specified by the Engineer. The base plate (soleplate) shall be common for the pump and motor. The cast iron pump head shall be free of blow holes, sand holes, and other detrimental defects and shall be capable to supporting the necessary column and pump assembly.

- E. The head assembly shall include an oil lubrication system, consisting of sight feed drip lubricator and a one gallon reservoir with watertight and dust tight cap.
- F. The maximum power input required to drive any pump shall not exceed the rated output horsepower of the motor. No overload will be allowed.
- G. The discharge column pipe shall be furnished in interchangeable sections not over twenty feet in length and shall be connected with threaded steel sleeve type couplings. The pipe size shall be such that the friction loss will not exceed four (4) feet per one hundred (100) feet, based on the rated capacity of the pump.
- H. Each column length shall be of steel pipe not lighter than that recommended by the latest American National Standards for vertical turbine pumps. The column shall have the standard wall thickness for the appropriate nominal diameter.
- I. The pump column length shall be equal to the depth of sump minus one-third the pump bowl diameter for lift pumps. The pump column length for deep wells shall be to the length specified by the Engineer.
- J. The line shaft shall be of carbon steel in accordance with ASTM A-108, Gr 1045, turned and ground. The line shaft shall be of ample size to operate the pump without distortion or vibration. The shaft shall be furnished with interchangeable sections not over twenty feet in length and shall be coupled with strong steel couplings machined from solid bar steel.
- K. The shaft enclosing tube shall be interchangeable sections, not over sixty (60) inches in length, of extra strong pipe to receive bronze couplings, which will also act as line shaft bearings. All threads shall be left-hand to prevent unscrewing during pump operation.
- L. The pump bowls shall be of close-grained cast iron, free from blow holes, sand holes, and all other faults. All surfaces shall be as smooth as practicable.
- M. The discharge case shall be provided with a bypass seal to reduce to a minimum leakage of water into the shaft enclosing tube, and must have bypass ports of sufficient area to permit the escape of water that leaks through the bushing or seal.
- N. The impellers shall be bronze or cast iron coated with vitreous enamel. They shall be semi-open or enclosed, accurately machined and statically balanced. They shall be securely fastened to the pump shaft in such a manner that they are easily removable. They shall be adjusted vertically by means of a nut in the motor head.

- O. The pump shaft shall be Type 416 stainless steel. It shall be supported by bearings above and below each impeller. The bowl assembly shall have sufficient strength to support the rotating parts of the pump on disassembly.
- P. On all deep wells, a suction pipe of the same diameter and material as the pump column shall be provided; its recommended length to extend below the first set of perforations.
- Q. The pump and motor shall be free of vibration and shall be equipped with a non-reverse ratchet assembly.

#### 2.04 ELECTRIC MOTORS

- A. The motors shall be premium efficiency squirrel cage, induction type, 460 Volt, three phase, 60 Hertz, vertical, hollow shaft, with RPM as required. The motors shall be especially suitable both electrically and mechanically to drive the pumps previously specified. The speed, horsepower, torques, thrust capacity, base, bearing and shaft shall be closely coordinated with pump requirements so as to provide satisfactory, efficient pump drive without over-loading, over-heating, or abnormal vibration. The horsepower requirements of the pump will not exceed the nameplate horsepower of the motor.
- B. Motors as manufactured by the General Electric Company, the Westinghouse Electric Corporation and the U.S. Motors Corporation, are acceptable if manufactured in accordance with these Specifications.
- C. The serving utility is the Pacific Gas and Electric Company. The motors shall be suitable for operation at ten percent (10%) above and below the rated voltage and five percent (5%) above and below the rated frequency.
- D. The motors in all cases shall meet, as minimum requirements, the published Standards of the National Electrical Manufacturers Association, the American Standards Association, and the Institute of Electronic and Electrical Engineers, as to application, manufacturing and testing methods.
- E. The motors shall be suitable for full voltage starting, NEMA design, Code Letter G, with normal torque and normal starting current. The motors shall be rated continuous for 176° F (80° C) rise above 104° F (40° C) ambient at 100% nameplate load with a 1.15 service factor.
- F. Enclosures and frames shall be of cast iron or heavy fabricated steel of such design and proportion so as to hold all motor components in proper position. The pump motors shall have shielded, drip-proof enclosures, WP-1, and all openings shall be screened. The motors shall have weather protection no less than that required by NEMA 1 construction. Lifting eye bolts shall be provided.

- G. The rotors shall be made from high grade laminated steel laminations securely fastened together and to the shaft. Rotor windings shall be either cast aluminum or bar type with brazed end or welded end rings.
- H. Windings will be adequately insulated and braced. Motor insulation shall be Class B. Windings shall be epoxy coated and impregnated with a fungicidal compound. Representative sample motors must have successfully passed the recommended NEMA performance tests. Coil extensions blocked and braced sufficiently to minimize movement during normal starting and running conditions at full rated voltage. Motor to include self regulating winding heaters.
- I. Bearings shall have AFBMA rated minimum life of three (3) years when operated continuously at rated speed. Bearings shall be of ample size to accommodate the weight of all rotating parts of the motor, plus the external hydraulic thrust with the unit operating continuously at the maximum thrust condition. Bearings shall be self-lubricated and shall have oil reservoirs of ample capacity each provided with oil level gauges and suitable connections for filling and draining. Thrust bearings shall be of the spherical roller or angular roller type. The guide bearings shall be of the ball bearing type. End play clearance shall be acceptable to the pump vendor.
- J. Motor guide bearings shall be oil or grease lubricated. There shall be a visual level indicator, an accessible drain plug, and an accessible filling plug for all oil-lubricated motors. The lubrication system shall be so designed as to provide the correct quantity of lubricant with minimum foaming or aeration.
- K. Name Plates:
1. Connection Diagram: Each motor shall have a stainless steel nameplate which indicates the motor connection diagram.
  2. Motor Data Information: Each motor shall have a stainless steel nameplate which shall provide the following: frame, type, horsepower, full load current, RPM, Celsius degree rise, manufacturers name, serial number, model number, phase voltage, locked rotor KVA code, and bearing numbers.
  3. Lubrication Information: Each motor shall have a stainless steel plate indicating all essential lubricating information such as type, viscosity, etc.
- R. Terminal boxes shall be cast iron or fabricated steel, watertight, neoprene gasketed and with adequate space for connections. The motor leads shall be permanently marked in agreement with the connection diagram. Termination facility for three (3) single conductors, 600 volt, insulated, shall be provided for the motor power supply service voltage specified in the Pump and Motor Data Sheet.
- S. Couplings shall be as selected by the pump vendor. Thrust values for

determination of bearing construction shall be provided to the motor manufacturers by the pump vendor.

- T. Accessories to be furnished with each induction motor shall consist of an oil level sight gauge for each oil reservoir, and motor space heaters at single phase line voltage of the motor.
- U. Spare Parts: One (1) set of thrust and guide bearings shall be furnished for each size and type of the three (3) phase induction motors.

## **PART 3 EXECUTION**

### **3.01 GENERAL**

- A. The installation of pumping units shall conform to the manufacturer's recommendations. The District reserves the right to reject any unit which does not comply with these Specifications or the information accompanying the Proposal.

### **3.02 INSTALLATION**

- A. The discharge column pipe joints are to be butted to ensure perfect alignment after assembly.
- B. The pumping column shall be disinfected during installation by swabbing with a minimum 200 ppm chlorine solution.
- C. The District will furnish the motor controller, the ground, service conduit and meter setting in accordance with the requirements of the Pacific Gas and Electric Company, at the Developer's expense.
- D. The conduit and conductor from the motor controller to the pump base will be installed by the District in coordination with the Contractor, at the Developer's expense.

### **3.03 SHIPPING**

- A. All parts shall be thoroughly cleaned to remove all oil, grease, dust and other foreign materials and all equipment openings capped to prevent entry of foreign materials. All units shall be packed so as to prevent damage during shipment. Shipping containers shall be marked with the pump number shown on the attached data sheets.

### **3.04 PAINTING**

- A. Ferrous surfaces of the pumping units that will be exposed shall be shop painted with three (3) coats of good quality commercial enamel by the manufacturer. The finish coat shall be a two-component aliphatic polyurethane coating of 4 mils of the District-selected color. The surface shall be properly prepared, per the paint

manufacturer's recommendation, prior to painting by removing all materials which would interfere with the bonding of the paint to the metal surface. The paint shall be applied as recommended by the paint manufacturer and shall be free of holidays or chips.

### 3.05 TESTING

- A. The pump characteristics shall be such that no humps, dips or flat spots occur in the head-capacity curves. The head shall decrease as the capacity increases.
- B. In determining the pump characteristics the following definitions shall apply:
  - 1. The total head shall be the difference in elevation between the water surface in the sump and the centerline of the discharge pipe at the discharge pressure gauge, plus the average pressure head at the discharge pressure gauge in feet of water, plus the velocity head at the discharge pressure gauge in feet of water.
  - 2. The velocity head shall be based on average velocity in the pipe at the discharge pressure gauge. The average velocity shall be based on the measured internal diameter of the pipe at the discharge pressure gauge and the measured capacity.
  - 3. The overall efficiency is the overall efficiency of the entire pumping unit including the motor, and the pump unit from the suction bell entrance or nozzle gauge to the discharge pressure gauge, and is defined as the ratio between the water horsepower delivered by the pump at the discharge pressure gauge to the electrical horsepower input to the motor. The water horsepower shall be based on the measured total head, as defined above, at a given measured capacity.
- C. The discharge pressure gauge for testing shall be located at least five (5) discharge pipe diameters downstream from the discharge elbow, or if a reducer or expanding cone is required, at least five (5) reducer or cone outlet diameters downstream from the reducer or expanding cone outlet.
- D. The pumps shall withstand a hydrostatic pressure test equal to one and one-half times the shutoff head or twice the operating head at the specified capacity, whichever is greater. The Contractor shall have conducted shop-running tests to determine the characteristics for all pumping units. Testing shall conform to the applicable provisions of AWWA E-101 or AWWA E-103, Section A6. Each pumping unit shall be completely assembled and then tested at design speed and to 125% of the design capacity. To successfully pass the laboratory running test, each pumping unit shall meet all performance requirements, including the overall efficiency stated in the Contractor's Proposal and shall not overload the electric motor over 100% of the nameplate horsepower and amps at any point within the operating range on the performance curve. Non-witness shop running tests are acceptable.

- E. The Contractor shall operate the pump(s) in the field to check for defects in the equipment or installation. The District reserves the right to reject any or all pumping units which do not comply with the Specifications or the information accompanying the Contractor's Proposal.

/// END OF SECTION

## SECTION 11285

### IRRIGATION GATES AND IRRIGATION VALVES

#### **PART 1 GENERAL**

##### 1.01 SECTION INCLUDES

- A. Slide gates, complete with frames, stems, stem extensions, stem guides, limit nut, solid rim lifting devices, anchor bolts and miscellaneous framing, which shall be furnished and installed by the Contractor.
- B. Flap gates which shall be furnished and installed by the Contractor.
- C. Alfalfa valves which shall be furnished and installed by the Contractor.
- D. The size and configuration of the various components shall be as indicated herein, in the Standard Details, and in the approved Improvement Plans, if any.
- E. All materials and installation shall be in accordance with the standards and specifications of the Solano Irrigation District, latest revisions.

##### 1.02 RELATED SECTION

- A. Section 01100 – General Requirements

##### 1.03 SUBMITTALS

- A. Before purchasing valves, gates and lifts, the Contractor shall submit to the Engineer two (2) complete sets of data and shop drawings covering the valves, gates and lifts that are proposed to be furnished.

##### 1.04 PAYMENT

- A. Payment for furnishing and installing slide gates will be made at the unit prices per gate bid therefor in the Bid Schedule. The unit prices bid shall include the cost of furnishing the gates, lifting devices, stem guides and extensions, metering well, discharge tables, and all labor and materials for assembling, installing and adjusting gates.
- B. Payment for furnishing and installing flap gates will be made at the unit prices per gate bid therefor in the Bid Schedule. The unit prices bid shall include the cost of furnishing the gates, extensions, discharge tables, and all labor and materials for assembling, installing and adjusting gates.
- C. Payment for furnishing and installing alfalfa valves will be made at the unit prices per gate bid therefor in the Bid Schedule. The unit prices bid shall include the

cost of furnishing the valves, piping, fittings, extensions, furnishing trenching, placing, backfilling, discharge tables, and all labor and materials for assembling, installing and adjusting valves.

## **PART 2 MATERIALS**

### **2.01 SLIDE GATES**

- A. Slide gates shall be Waterman Canal Gate Model C-10, unless otherwise indicated on the drawings. Each size of slide gate used as a turnout shall be calibrated for measuring water. Gates shall be provided with rising stem extensions as needed.
- B. The Contractor shall assume responsibility for a coordinated and adequate design. The gates shall have self-rising stems projecting a minimum of one inch (1") above the hand wheel when the gate is fully closed. The stem shall have right hand threads and be equipped with a limit nut to prevent overstressing. The gates shall be equipped with bronze lifting nuts, stainless steel anchors and wedge blocks arranged to force the gate slides against their seats. The gate slides and seats shall be cast-iron with bronze seat facing. The gate frames shall be galvanized. The gates shall have flat back or spigot back type seats as provided for on the drawings. All gates shall be furnished with the frame and gate stem extensions as shown on the drawings, where necessary.

### **2.02 FLAP GATES**

- A. Flap gates shall be Waterman Model F-10 or as indicated in the Drawings. The gates shall have a seat suitable for mounting on a steel pipe, corrugated pipe or a concrete head wall, as required. The seat shall be cast iron with stainless steel hardware.

### **2.03 ALFALFA VALVES**

- A. Alfalfa valves shall be solvent weld Waterman "Red Top" Alfalfa Valves with removable arch and acme threads.

## **PART 3 EXECUTION**

### **3.01 SLIDE GATES**

- A. The Contractor shall install all gates as shown on the Drawings. The gates shall be secured to the concrete wall with preset anchors or tap-in anchors with studs. Tap-in anchors shall be Phillips Red Head or approved equal. Either method is optional to the Contractor. The gate frame shall be secured evenly and accurately into position in such a manner as to prevent springing the gate seat. This shall be accomplished by the use of a suitable nut or spacers between the gate and the wall, as directed by the Engineer. The space between the gate seat and the wall shall be

completely filled with an approved grout or mastic. Anchor bolts shall be located in the structure by the Contractor from the slide gate drawings and data furnished by the manufacturer.

- B. After the gates are completely installed, each gate will be tested by the Engineer, and any required changes or adjustments will be performed by the Contractor. Clearance between the gate face and the gate seat shall not exceed three-thousandths of an inch (.003") at any point. The opening on concrete walls, where gates are to be attached shall have a diameter equal to the diameter of the gate and equal to the inside diameter of the pipe.

### 3.02 FLAP GATES

- A. The Contractor shall install all flap gates as shown on the Drawings or as directed by the Engineer.

### 3.03 ALFALFA VALVES

- A. The Contractor shall install all alfalfa valves as shown on the Drawings, or as directed by the Engineer.

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## SECTION 13400

### SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)

#### PART 1 - GENERAL

##### 1.01 SECTION INCLUDES

- A. Section includes furnishing and installing of a complete and operational SCADA site capable of monitoring and controlling the District facility.
- B. SCADA equipment will consist of 'PROGRAMABLE LOGIC CONTROLLER (PLC)', 'INSTRUMENTATION', 'COMMUNICATIONS', 'SOFTWARE', and custom 'PROGRAMMING'.

##### 1.02 RELATED SECTIONS

- A. Section 16010 – Basic Electrical Materials and Methods
- B. Section 16100 – Wiring Methods
- C. Section 16400 – Distribution and Grounding

##### 1.03 SUBMITTALS

- A. Product Data: Submit manufacturers' technical product data in compliance with these Specifications and Plans or other specifications that will influence the proper operation of the system.
- B. Shop Drawings: Submit layout drawings and other data, as required, to indicate methods of installing and attaching equipment.
- C. Manufacturers recommended installation procedures.
- D. Operation and Maintenance manuals describing programming instructions, equipment descriptions, shop drawings, cabinet wiring, etc., in accordance with Section 00700.6.11.
- E. A fully documentable programmable logic controller (PLC), including tag names, in an electronic format.

##### 1.04 QUALITY ASSURANCE

- A. All SCADA equipment will be of the latest technology and in current manufacture by a manufacturer who has been approved by the District as outlined in the District's current SCADA Masterplan.

## PART 2 - MATERIALS

### 2.01 PROGRAMABLE LOGIC CONTROLLER (PLC)

#### A. Electrical Requirements:

1. PLC's are to be supplied as an integral part of a complete electrical or control panel package, or in a stand alone enclosure NEMA approved for the weather it is placed in where shown. All incoming and out going wires connecting digital and analog signals will be via a terminal strip associated with the PLC.
2. The PLC will accept 120VAC or 10-30VDC as its power supply and contain the necessary transformers and/or rectifiers (if needed) to distribute proper voltage to the electronics.
3. Provide integral online UPS charger with gel-cell. The UPS shall be the Liebert GMT1000 with web card and pod, Tripp Lite SU1000LSA with web card with SNMP, or approved equal.

#### B. Control Requirements:

1. The PLC shall be a SCADAPAK 334, SCADAPAK 350 with integrated I/O modules, or Allen Bradley CompactLogix L30ER-NSE and shall be the manufacturers most current version.
2. PLC's are manufactured complete packages designed to monitor digital inputs, control normally open 120VAC output contacts, monitor PLC excited variable 4-20ma signal inputs, and output PLC excited 4-20ma variable signals.
3. It is the responsibility of the Telemetry/Control Contractor to provide enough input/output, volatile and non-volatile memory, and power to produce the desired effect of the specified programming and physical input/output.
4. The PLC shall provide two RS-232 ports, one RS-485 port, one Ethernet and one USB port.
5. Each port shall be software configurable for parity, word length, baud rate, etc. The configuration shall be stored in EPROM. All common combinations such as odd, even or no parity, seven or eight data bits, will be supported. The ports shall be capable of 9600 baud to 19200 baud. The communication ports must be fully usable and equally accessible to the application program. It shall be possible to edit the PLC program on any port.

6. The PLC will provide a hardware clock/calendar which is accurate to one minute per month. The clock/calendar must be powered by the same lithium battery which retains the RAM to simplify routine maintenance. The PLC shall be equipped with a watchdog timer which will automatically restart the unit in the event of power failure, processor "crash" or application program malfunction. Upon watchdog timer reset, all outputs must turn off, and the modems must disconnect from the communication network. The watchdog timer output must be available to drive an external annunciator.
  7. Input/Output Requirements: Minimum I/O shall be 4 each isolated 0-20 mA, 14-bit resolution plus sign bi-polar analog inputs, 4 each isolated 0-20 mA 12-bit resolution analog outputs, digital I/O = SEE PLANS PLUS 20% spare, and counter = 8. Real time support consists of 16 PID feedback controller algorithms, and minimum 32 software timers.
- C. PLC programming: The software will provide the District integrator the means for customizing the operating program of the system to perform the specified control, monitoring, alarming, and transfer function of data between the PLC's and the central station computer software.
1. The PLC program shall be compatible with Telepace Studio or RSLogix 5000 programming software.
- D. The Operator Interface Terminal (OIT) shall be an Allen-Bradley PanelView, if applicable, IDEC HG3G, or approved equal.

## 2.02 INSTRUMENTATION

### A. Level Transducers

1. Remote solar powered sites shall use a sealed pressure transducer that is rated for 9 to 32 volt power input and shall reference gauge pressure. The pressure transducer shall be model 347 or 570 as manufactured by Viatran, or approved equal. The transducer shall be provided with the necessary fittings or required length of wire.
2. Site equipped with available AC power shall use pressure transducers with an integral LCD display, are equipped with a block and bleed manifold and reference gauge pressure. The transducers shall be a Rosemount 3051, Siemens Sitrans P, Endress & Hauser PMP 71, or approved equal.
3. Submersible pressure transducers shall be equipped with a breather tube and desiccant terminator. The Contractor shall provide the District with an additional extra desiccant terminator. The submersible transducer shall be rated for 9 to 32 volt power input and shall reference gauge pressure. The transducer shall be a Viatran 570 or approved equal. The transducer shall be provided with the required length of cable.

4. Ultrasonic level sensor shall be rated for 9 to 32 volt power input. The sensor shall be model 873P as manufactured by Allen-Bradley or approved equal. The sensor shall be provided with the necessary length of cable.
5. The Contractor shall select the appropriate range for the sensor application.
6. All sensors shall have a 4-20 milliamp output.
7. All sensors shall have an accuracy of  $\pm 0.1\%$  of its full scale.

B. Meters

1. Remote solar powered sites may be equipped with any District approved meter capable of 4-20 milliamp output or closed dry contact output. The meter, if necessary, shall be rated for 9 to 32 volt power input.
2. Sites equipped with available AC power shall use a magnetic flow meter with integral ground rods, 4-20 milliamp output, and pulse output. The meter shall be a McCrometer Ultra Mag, Siemens Sitrans Magflow, or approved equal.
3. Open channel flow measurement sites shall use the Sontek Argonaut IQ.
4. The Contractor shall provide the District with all the necessary modules, adapters, wiring, or other electrical appurtenances to meet the District's requirements.

C. Switches

1. Limit or hatch switches shall have a discrete output and have the correct power rating for the application.

## 2.03 NETWORK PROTOCOL

- A. Network protocol shall be either MODBUS TCP via Ethernet or ABTCP/CIP.

## 2.03 SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)

A. Central Computer

1. The District's existing computer server will monitor the status of all motors, data, and systems, monitor and report alarms, store chosen variables in a data file with time and date stamp, trend analysis, changing of set points and program in PLC's, and report generation.

B. SCADA Software

1. All new SCADA sites shall be integrated into the District's existing ClearSCADA HMI.

2.04 RADIOS

A. Radios:

1. Spread spectrum: Trio JR900 Ethernet radio
2. Licensed fixed frequency: CalAmp Viper SC Ethernet radio

B. Antennas:

1. Omnidirectional Antennas: minimum 10dB gain.
2. Directional Antennas: minimum 10dB gain.
3. Antenna Supports: shall be per the manufacturer's recommendations or as approved by the Engineer.

C. Miscellaneous:

1. Power Supplies:
  - a. Solar - Morningstar charge controller or approved equal.
  - b. Low voltage - Allen-Bradley power supply or approved equal.
2. Cabling
  - a. Ethernet Cable: CAT 5E
  - b. Signal Cable: Belden 8760 twisted shielded pair or approved equal.
  - c. Low Voltage Power Cables: 18 gauge 2 conductor twisted pair.
  - d. Antenna Cable and Connectors:
    - i. RG8 or LM400 coaxial cable
    - ii. Crimp-on connectors are not permitted.

D. Ethernet Switches:

1. N-Tron industrial Ethernet switches or approved equal.

E. Batteries:

1. Gel cell or sealed lead acid. Batteries shall be sized for seven (7) consecutive days of cloudy skies in the Solano county area.
2. The battery back-up UPS shall be sufficiently sized to operate the PLC and its related I/O for ten (10) hours.

**PART 3 - EXECUTION**

3.01 INSTALLATION

- A. System will be installed per Manufacturer's specifications.
- B. All PLC, OIT, and HMI programming shall be conducted by the District's integrator.
- C. The Contractor shall install clamp-on style current sensors on leads to all devices to monitor their running state.
- D. The Contractor shall install switches on all enclosure doors and water tank hatches.
- E. All wire shall include an extra pair of 22 gauge wires that shall be shorted together at the termination of the wire run. The end exposed inside the control cabinet shall be tied into one of the PLC's digital inputs and monitored for an open situation.

3.02 TESTING AND STARTUP

- A. The District's integrator will be present when the Contractor tests the equipment in accordance with manufacturer's and District's recommendations and requirements.

/// END OF SECTION

## SECTION 16010

### BASIC ELECTRICAL MATERIALS AND METHODS

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. The Contractor shall provide all materials, tools, equipment, labor and services necessary to furnish and install complete working electrical systems as shown on the Plans and described within these Specifications. The Contractor shall furnish all power supplies, disconnects, controls, and any other work as called for in the other Sections of these Specifications and Plans as well as all electrical and electrical related work as called for in the Specifications and Plans. All systems, at project completion and before final acceptance, shall be demonstrated to have a complete and working functional operation. The work includes but is not specifically limited to items indicated below.
- B. Electrical Distribution and Communication:
  - 1. Electrical Service: Electrical Service is new. Contractor to furnish and install along with electric and telephone utility requirements.
  - 2. Trenching, conduits and feeders for connecting electrical power and controls.
- C. Installation and Connection of Process Equipment:
  - 1. All trenching, conduits, and wires to connect all equipment associated with the process system in need of electrical power or controls.
  - 2. Termination of all control and power conductors into all panels either furnished and installed by the Contractor or furnished by Others and installed by the Contractor.
  - 3. Mounting and securing of all electrical related equipment given to the Contractor by Others.
- D. Building and Mechanical Systems:
  - 1. Complete lighting, power, and control systems.
  - 2. Electrical work associated with process equipment.
- E. Furnish and install off site materials and cables as shown.
- F. Permits and fees relating to electrical work.

## 1.02 RELATED SECTIONS

- A. Section 01100 – General Requirements
- B. Section 16100 – Wiring Methods
- C. Section 16400 – Distribution and Grounding
- D. Section 16500 – Lighting

## 1.03 CONTRACT REQUIREMENTS

- A. The foregoing General Provisions, Special Provisions, Technical Specifications, and supplements thereto, all requirements of the general contractual requirements of these Specifications, and the Drawings shall form a part of, and apply to the work of, this section with the same force and effect as though repeated herein. The provisions of this section shall apply to all of the following sections of these Specifications.

## 1.04 CODES AND REGULATIONS

All electrical equipment and material and its installation shall conform to the current requirements of the latest editions from the following authorities. Where two or more codes conflict, the most restrictive code shall apply. Nothing in these Plans and Specifications shall be construed to permit work not conforming to applicable codes.

- A. California Occupational Safety and Health Act (Cal OSHA).
- B. National Electrical Code (NEC).
- C. California Code of Regulations (CCR).
  - 1. Title 8, Safety Orders.
  - 2. Title 19, Fire and Panic Safety Standard.
  - 3. Title 24, Building Standard.
- D. Uniform Building Code, Fire and Panic Safety.
- E. Uniform Mechanical Code.
- F. Uniform Plumbing Code.
- G. National Fire Code.
- H. Pacific Gas and Electric Service Requirements.

## 1.05 TESTS AND STANDARDS

The tests, standards, or recommended procedures of the following agencies shall relate to all parts of these Specifications and shall be considered a minimum.

- A. American National Standards Institute (ANSI).
- B. Underwriters Laboratories, Inc. (UL).
- C. National Electrical Manufacturers Association (NEMA).
- D. Electrical Testing Laboratories (ETL).
- E. National Fire Protection Association (NFPA).
- F. Insulated Power Cable Engineers Association (IPCEA).
- G. Institute of Electrical and Electronic Engineers (IEEE).
- H. Illumination Engineering Society (IES).
- I. National Electrical Testing Association, Inc. (NETA)

## 1.06 DESCRIPTION AND INSTALLATION OF SYSTEMS

- A. The electrical drawings are diagrammatic/schematic and do not necessarily show all raceway, wiring, number or types of fittings, offsets, bends or exact locations of items required by the electrical systems. Items not shown or indicated, which are clearly necessary for proper operation or installation of systems shown, shall be provided at no increase in contract price.
- B. The exact routing of systems and location of devices and equipment shall be governed by coordination with other trades, and structural and architectural conditions. The Electrical Engineer reserves the right, at no increase in contract price, to make reasonable changes in location of electrical equipment or wiring system so as to coordinate with other systems, to group them into orderly relationships, or to increase their utility. Contractor shall verify requirements in this regard prior to roughing in.
- C. Install electrical work in cooperation with other trades, make proper provisions to avoid interferences, and coordinate with structural and architectural feature in a manner approved by the Electrical Engineer. All changes caused by neglect to make such provisions shall be at Contractor's expense. Provide offsets and special fittings, as required to facilitate installation of the work.
- D. When a particular product or type of product is specified with a manufacturer's designation, the latest published specifications, installation, and construction

information of the manufacturer shall constitute the minimum acceptable standard. Any substitutions shall be made in accordance with the requirements hereinafter specified.

- E. Types of electrical related work specified in this section include the following:
  - 1. Excavating for Electrical Work: Underground electrical wiring and service tunnels. Independent (isolated) foundations. Underground electrical vaults.
  - 2. Concrete for Electrical Work: Lean concrete backfill to support electrical work. Encasement of electrical work. Underground structural concrete to accommodate electrical work. Vaults for electrical work. Electrical equipment foundations and mounting pads. Rough grouting in and around electrical work. Patching concrete which has been cut to accommodate electrical work.

#### 1.07 SUBSTITUTIONS

- A. Those products, or types of products, listed and specified are intended to set the standard for quality, design, and installation procedure required for the project. The Contractor shall not substitute other materials, products or systems without the written approval of the Electrical Engineer.
- B. All requests for substitution shall be made in accordance with the requirements of the General Conditions, if any.
- C. All requests for substitution shall be in writing and shall indicate all information required thereon, including differences from the specified item. The request for substitution shall be accompanied by cuts, product literature, performance data, Specifications, Drawings, samples or other means as may be required for proper evaluation by the Electrical Engineer.
- D. All proposed substitutions shall be a standard product of the firm, under current manufacture and be a catalog item at time of bid.
- E. Acceptance of substitutions shall not relieve the Contractor from responsibility for complying with requirements of the Contract Documents. The Contractor shall be responsible for changes in other parts of the work occasioned by his substitutions and shall bear the expense.
- F. Representative samples may be required for determination of equality.

#### 1.08 SUBMITTALS

- A. General: Make submittals for all material to be used on the project, whether as specified or substitutions, within thirty (30) days after award of Contract by the District, in accordance with General Conditions and the following:

1. All submittals shall be neat and bound in a suitable folder or binder.
2. Identify each item by manufacturer, brand, trade name, number, size rating, and whatever other data is necessary to properly identify and check materials and equipment. Words "as specified" are not sufficient identification.
3. Identify each submittal item by reference to Specifications section paragraph in which item is specified, or Drawing or Detail number.
4. All submittals shall be submitted in coherent groups, e.g., all light fixtures at one time. No partial or incomplete submittals will be accepted.
5. Organize submittals in the same sequence as they appear in specification sections, articles, or paragraphs.

B. Product Data: Submit a minimum of three (3) copies, in groups, as follows:

1. Conduits and raceway types required, including fittings
2. Electric wire, cable and connectors
3. Electrical boxes and fittings
4. Wiring devices
5. Panelboards and terminal cabinets
6. Disconnect switches
7. Each type of support, anchor, sleeve, and seal
8. Lighting fixtures
9. Time clocks
10. Lighting Controls
11. Transformers
12. Service entrance equipment
13. Switchboards
14. Motor Control Centers
15. Motor Starters
16. AC Drives
17. Splice Kits
18. Fire Stopping Material
19. Signal System Devices
20. Pullboxes
21. Control Equipment

C. Manufacturer's Data: Submit manufacturer's data including specifications, installation instructions, and general recommendations for each item submitted under submittals. Submit calculations in accordance with these Specifications.

D. Shop Drawings:

1. Upon product review, submit shop drawings showing physical arrangement, wiring diagrams, construction details, finishes, materials used in fabrication, provisions for conduit entrance, access requirements

for installation and maintenance, physical size, electrical characteristics, foundation and support details, weight, power sources, circuit numbers, and shall be compatible with the Contract Drawings and Specifications.

2. Show wiring as actually installed, connected, and identified for this specific project. Include identification of cables and cable conductors.
  3. Shop and instruction drawings shall cover the equipment or device to be installed and not merely the general class of such equipment or device.
- E. Samples: Submit single, factory boxed production run samples identical to equipment to be supplied, as follows. Samples will be retained for analysis and comparison purposes.
1. Receptacles and switches
  2. Base Cover plates
  3. EMT conduit connectors
- F. Seismic Restraint Calculations: Submit calculations prepared and signed by a Structural Engineer licensed in the State of California, showing compliance with Title 24, Section 2-2312 and Table 2-23J, and all provisions of this Section, for the lateral and vertical support of conduit and electrical equipment, all corresponding exactly in configuration and weight to those specified and detailed. Where anchorage details are not shown on drawings, the field installation shall be subject to the approval of the Electrical Engineer.
- G. Test Reports: Submit complete test reports with maintenance manual submission.
- H. Construction Record Drawings:
1. The Contractor shall furnish to the Engineer a complete set of "as constructed" drawings which clearly indicate all deviations from the basic Contract Drawings, including exact dimensioned locations and depths for all stubbed conduits, location and size of spare conduits and conductors, all new and uncovered existing work outside the buildings, power feeder runs, and communications "primary" conduit runs. Corrections and changes shall be kept up-to-date at all times.
  2. All submittals and shop drawings shall be resubmitted with record drawings showing all revisions and changes made, clearly marked with field termination wire so as to reflect actual construction record conditions. Revision and changes will be enumerated and new dates of drawings shown.
- I. Operation And Service Manuals:
1. Contractor shall prepare manuals describing the operations, service, and maintenance requirements of, and complete parts lists for all electrical

equipment (two [2] identical and complete sets: one hard copy & one electronic copy).

2. Equipment described in the manual shall include all equipment listed under subsection 1.07.B – Product Data, and all other auxiliary miscellaneous systems.
3. Information contained in the manual shall consist of 8½" x 11" size catalog data on each item, together with parts lists, description of operation, maintenance information, shop drawings, wiring and riser diagrams, and test reports as installed. Catalogs and data in the manuals shall be neat, clean copies. Drawings shall be accordion folded to letter size and installed in an envelope within the manual. An index shall be provided, which shall list all contents in an orderly manner with the respective equipment supplier's name, address and telephone number, and the manufacturer's recommended servicing instructions. Diagrams shall be complete for each system installed. Provide divider sheets with identifying tabs between each category.

#### 1.09 GUARANTY

- A. The Contractor agrees to replace or repair, to the satisfaction of the District, any part of the installation which may fail due to defective material and/or workmanship or failure to follow Plans and Specifications, for a period of one (1) year minimum, after final acceptance. Any damage to other work resulting from such failure or the correction thereof shall be remedied at the Contractor's expense. The Contractor shall further secure from the manufacturers of special equipment, such as signal systems, their respective guaranties and deliver same to the District. Guaranties between Contractor and his suppliers shall not affect guaranties between Contractor and the District.

#### 1.10 ELECTRICAL PAYMENT

- A. Payment shall include furnishing and installing the electrical work as described within these Specifications and as shown on the Drawings.

### **PART 2 MATERIALS**

#### 2.01 GENERAL

- A. Electrical materials shall be new and of the best quality used for the purpose in good commercial practice.
- B. UL Approval: All material and equipment within the scope of the UL reexamination service shall be approved by the Underwriters Laboratories for the purpose for which they are used and shall bear their label.

- C. Storage: All material and equipment shall be stored in a manner to prevent damage or corrosion. Equipment with components which can be damaged by moisture shall be placed in special heated storage facilities.
- D. Drawings: Drawings for all equipment are intended to be diagrammatic/schematic only. Any location not actually dimensioned is not to be considered as necessarily final or accurate. Exact locations must be determined in the field from the requirements of the equipment that is to be installed.
- E. Coordination: Before rough-in of any utility lines, services, and feeders, or of any equipment, the Contractor must coordinate its work with that of other crafts and trades so that these services shall be installed in their proper locations and without interference to the equipment or building structure. This will require cooperation among all crafts and trades, the inspector, and General Contractor, along with study of shop drawings and the building plans.
- F. Electrical Work Exposed To Weather:
  - 1. All electrical devices and equipment installed in exposed locations shall be protected by suitable NEMA type 3R enclosures, cast steel boxes with gasketed steel covers, or other Engineer approved methods.
  - 2. All ferrous metal portions of electrical work exposed to weather including conduits, clamps, supports, etc. shall be hot-dip galvanized steel.

## 2.02 BEDDING AND BACKFILL MATERIALS

- A. Conduit Bedding Material: Well graded sand, gravel, or crushed stone, with 100% passing a 3/8" sieve.
- B. Trench Backfill Material: Sandy or silty loam, free of lumps, laid in 6" layers, uniformly mixed to proper moisture and compacted to required density.

## PART 3 EXECUTION

### 3.01 GENERAL

- A. Workmanship: The work shall be performed by competent workmen, skilled in the particular phase of the work entailed. The work shall be first class throughout, neat, accurate and in full accordance with the intent of these Specifications, and to the satisfaction of the Electrical Engineer.
- B. Coordination: The Contractor shall familiarize himself with the work of other crafts so as to be able to provide electrical service of correct size, voltage, and other requirements to any equipment to be installed. The installations shall coordinate as to location and time, and interference causing delays and non-acceptable construction shall be avoided. Prior to commencing construction the Electrical Contractor shall arrange a conference with the Mechanical and Plumbing Contractors and sub-contractors as well as equipment suppliers, and

shall verify types, sizes, locations, requirements, controls, and diagrams of all equipment furnished by them. Prior to roughing in, he shall inform the Electrical Engineer, in writing, that all phases of coordination of this equipment have been covered. Exact equipment rough-in locations shall be verified from shop drawings.

- C. Cutting and Repairing: The Electrical Contractor shall do all cutting necessary for the proper installation of his work, repair any damage done by himself or his workmen, and coordinate his work with that of others. No cutting or patching shall be done without approval of the Electrical Engineer. Round holes through concrete slabs or walls shall be core drilled with a diamond drill; rectangular openings shall be cut with a diamond saw. In no case shall any concrete beam or column be cut.
- D. Sleeves and Openings: The Electrical Contractor shall be responsible for all sleeves and openings through walls and floors required by electrical work. All openings around conduits in sleeves shall be sealed with a material of equal fire rating as the surface penetrated. Openings not utilized shall be temporarily sealed in a similar manner. All required sleeves shall be furnished to and coordinated with the General Contractor.
- E. Cleaning and Painting: All exposed work shall be thoroughly cleaned upon completion of work. Panel board enclosures, fixtures and equipment, where finish has been marred in shipment or installation, shall be completely refinished. Minor finish damage shall be rectified as indicated by the Electrical Engineer. Contractor shall remove from the site all waste and rubbish resulting from its work.
- F. Demolition: Where called for in the Drawings, remove existing equipment, structures, etc., to the lines shown thereon.
- G. Continuity of Service:
  - 1. Continuity of Service: The Contractor shall coordinate any down time with the District after permanent power is turned on.
  - 2. Utility Work Approval: The Contractor shall give required notice and obtain approval from the utility company prior to commencing work.

### 3.02 GROUNDING

- A. The conduit system supports, cabinets, switchboards, etc, and neutral conductors must be permanently and effectively grounded by means of approved ground clamp, in accordance with the electrical safety orders of the Department of Industrial Relations of the State of California.
- B. This Contractor shall exercise every precaution to obtain good contacts at all panel boxes, pull boxes, etc. Where it is not possible to obtain good contacts, the conduit shall be bonded around the boxes with a #6 (minimum) B&S gauge,

rubber covered, double braided wire with ground clamps.

- C. Equipment and raceway bonding procedures shall be rigidly maintained and meet all jurisdictional requirements of codes and regulations.

### 3.03 SEISMIC RESTRAINT AND ANCHORAGE

- A. Provide complete seismic anchorage and bracing for the lateral and vertical support of conduit and electrical equipment in accordance with Title 24, Section 2-2312 and Table 2-23J, all provisions of this Section, and the seismic calculations required to be submitted.
- B. All equipment mounted on concrete shall be secured with steel stud expansion anchors requiring a drilled hole. Powder driven anchors are not acceptable. Minimum spacing shall be ten (10) diameters center to center and five (5) diameters center to edge of concrete. Maximum allowable stresses for tension and shear shall be 80% of the ICBO test report values. Expansion anchors shall be Hilti, Phillips, or approved equal.
- C. Conduit and suspended equipment shall be provided with supports and seismic restraints in accordance with the current "Guidelines for Seismic Restraint of Mechanical Systems and Plumbing Piping Systems", as published by the Sheet Metal Industry Council Inc., Los Angeles, California, or the Super Strut Inc., seismic restraint system. Support requirements shall be based upon similar equipment; i.e., water piping as equivalent to conduit with wire fill.

### 3.04 EXCAVATING FOR ELECTRICAL WORK

- A. Do not excavate for electrical work until work is ready to proceed without delay, so that total elapsed time from excavation to completion of backfilling will be minimal. Coordinate excavations with weather conditions, to minimize possibility of washouts, settlements and other damages and hazards.
- B. Excavate with vertical-sided excavations to greatest extent possible, except where otherwise indicated. Where necessary, provide sheeting and cross-bracing to sustain sides of excavations. Remove sheeting and cross-bracing during backfilling wherever such removal would not endanger the work or other property. Where not removed, cut sheeting off at sufficient distance below finished grade to not interfere with other work.
- C. Dewatering: Maintain dry excavations for electrical work by removing water. Project excavations from inflow of surface water. Pump minor inflow of ground water from excavations.
- D. Width and Cover: Unless otherwise noted, minimum earth cover above conduit shall be 36". Excavate for conduit with 3" clearance at both sides of conduit, except where otherwise shown or required for proper installation of joints and fittings. Excavate for other electrical work to provide minimum practical but adequate working clearances.

- E. Depth for Subbase Support: Where installation of subbase material is indicated, excavate for installation of subbase material in depth indicated or, if not otherwise indicated, 6" below bottom of work to be supported.
- F. Excavate near large trees (within drip line) by hand, and protect the root system from damage or dry out to greatest extent possible. Verify trench locations with Engineer prior to trenching. Maintain moist condition for root system and cover exposed roots with burlap. Paint root cuts of 1" diameter and larger with asphaltic tree paint.
- G. Store excavated material (temporarily) near excavation, in manner which will not interfere with or damage excavation or other work. Do not store under trees (within drip line).
  - 1. Retain excavated material which complies with requirements for backfill material.
  - 2. Dispose of excavated material which is either in excess of quantity needed for backfilling or does not comply with requirements for backfill material. Remove unused material from project site, and dispose of in lawful manner.
- H. Boring and Cutting:
  - 1. Where trench crosses concrete walks or paved areas bore or saw cut and patch as required for conduit installation. Boring shall be by screw auger or dry ramming. Where soil conditions warrant, (water boring may be allowed on a case-by-case basis upon approval of the Engineer). No water jetting shall be allowed.
  - 2. Bore and saw cut as indicated on the Plans, or where not indicated; bore under walks 10'-0" wide or less, saw cut walks wider than 10'-0".
  - 3. Depth of saw cutting shall be no greater than 1/4" below slab thickness.

### 3.05 BACKFILLING ELECTRICAL WORK

- A. General: Except as otherwise indicated, backfill with properly qualified backfill material.
- B. Backfill with Conduit Bedding Material to 6" above conduits.
- C. Condition backfill material by either drying or adding water uniformly, to whatever extent may be necessary to facilitate compaction to required densities. Do not backfill with frozen soil materials.
- D. Backfill simultaneously on opposite sides of electrical work, and compact simultaneously. Do not dislocate the work from installed positions.

- E. Backfill excavations in 6" high courses of backfill material, uniformly compacted to the following densities as % of maximum density, (ASTM D1557), using power-driven hand-operated compaction equipment. If backfill is determined to be suitable and required compaction is demonstrated by laboratory test, water compaction in 6" layers may be used, subject to review by Engineer.

Lawn/Landscaped Areas: 85%  
Paved Areas, Other Than Roadways: 90%  
Roadways: 95%

- F. Backfill to elevations matching adjacent grades, at time of backfilling excavations for electrical work.
- G. Compaction Test: Demonstrate proper compaction by testing at one-half of the trench depth.
- H. PG&E conduits shall have red colored concrete cap per PG&E requirements.
- I. Excavation Performance and Maintenance:
  - 1. Subsidence: Where subsidence is measurable or observable at electrical work excavations during general project warranty period, remove surface (pavement, lawn, or other finish), add backfill material, compact, and replace surface treatment.
  - 2. Restore appearance, quality and condition of the surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

### 3.06 INSTALLATION OF CONCRETE WORK

- A. Install concrete for electrical work in accordance with Section 03300 – Cast-in-Place Concrete.

### 3.07 INSPECTIONS AND TESTS

- A. The Contractor shall furnish all labor and test equipment required to fully test and adjust the equipment installed under this specification and demonstrate its proper operation, in accordance with the General Conditions.
- B. The Contractor shall arrange for all tests and inspections and provide minimum 48 hours prior notice to the Electrical Engineer.
- C. A test must demonstrate that each piece of equipment, outlet, fixture, device, and appurtenance is in sound operating condition and in proper cooperative relation to associated equipment.

- D. All tests shall be conducted under supervision of the District or its designated representative, and any defects of any nature which are apparent as a result of such test shall be made correct to the satisfaction of the Electrical Engineer before final acceptance is made.
- E. No equipment shall be tested, or operated for any other purpose, such as checking motor rotation, until it has been fully checked in accordance with the manufacturer's instructions.
- F. Check and tighten nuts, bolts, lugs, and similar elements of equipment; switchboards, motor control centers, busways, panels, etc.
- G. Work Correction: Any portion of the work which does not perform satisfactorily or any defects which are disclosed by testing shall be corrected by the Contractor at its expense before work will be accepted.

### 3.08 PORTABLE OR DETACHABLE PARTS

- A. The Contractor shall retain in its possession, and shall be responsible for, all portable and detachable parts or portions of the installation, such as fuses, keys, locks, adapters, locking clips, and inserts, until final completion of the work. These parts shall be itemized and delivered to the District at Project Closeout.

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## SECTION 16100

### WIRING METHODS

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Furnishing and installing conduit, wiring boxes and devices, conductors and cables.

##### 1.02 RELATED SECTION

- A. Section 16010 – Basic Electrical Materials and Methods

#### PART 2 MATERIALS

##### 2.01 CONDUIT MATERIALS AND COMPONENTS

- A. Threaded Metal and Rigid: All locations as follows excepting those specifically indicated for EMT and PVC. All exterior locations above grade, in concrete walls and slabs, exiting concrete block walls in exposed or above ground areas, or elsewhere shown on Plans. Runs within, passing through, or above hazardous areas shall be rigid with appropriate seal-offs as per Code. Rigid conduit shall be new galvanized threaded, conforming to UL 6. All couplings and connectors shall be threaded. Rigid metal conduit shall be specifically used on roofs or on all surfaces of corridor and walkway coverings. Rigid conduit will be used to exit in exposed locations from under ground PVC runs. Exit will include upward bend from the horizontal run and vertical riser. Vertical riser will continue to the first point of conduit termination above ground. At NEMA 3R locations, rigid conduit shall enter boxes through hubs provided or Meyers type hubs. Sealing locknuts are not acceptable. All under ground and/or rigid conduits in concrete and risers from under ground runs will be rigid steel with factory applied PVC coating on the outside with comparable fittings. Use only manufactures recommended methods and tools for installation of PVC coated conduits. Any PVC coating showing scratches and/or indentations due to improper installation will be replaced at the discretion of the Engineer and/or Owner.
- B. Thin Wall E.M.T.: Interior dry locations above ground, exposed only above 60" above floor in non-finished areas where not subject to physical abuse or damage. E.M.T. shall be new galvanized, conforming to UL 797, furnished in 10 foot lengths. E.M.T. shall be coupled with steel set screw type couplings with nylon insulated throats. Crimp type or die cast connectors are not acceptable.
- C. Flexible Metallic Steel Conduit: Only to be used to connect lay in fluorescent lights.
- D. Flexible Liquid-tite Metallic Conduit: Connections to machinery. Conduit shall be flexible interlocking single strip steel conduit with liquid tight exterior cover,

with all connections made with galvanized steel liquid tight with "O" ring gaskets with nylon insulated throats and with copper ground wire (maximum length 36"), American Brass Sealtight or equivalent, conforming to UL 1. All flexible conduits will contain a ground wire with minimum size as per NEC.

- E. Plastic PVC: Underground locations and below vapor barrier of slabs, and in solid grouted masonry walls where exposed wall entry and exit points are made with PVC coated rigid galvanized steel conduit. No plastic conduit shall be installed in slab floors or concrete slabs, concrete footings, or in exposed locations. PVC conduit shall be Type 40 heavy thick wall polyvinyl chloride conduit, Underwriters' Laboratories tested, furnished in 10 or 20 foot lengths, conforming to UL 651-77.

## 2.02 WIRING DEVICES

- A. Outlet and Switch Boxes: Boxes, where recessed in walls, shall be one piece die formed galvanized steel of shape and with fittings necessary to suit location and use. Boxes shall be of sufficient size to contain all wires, devices, and connection fittings required without crowding, minimum 2 gang for receptacles. Ceiling and surface mounted boxes shall be minimum 4" square. Plaster rings shall be provided where required. Exposed Boxes shall be cast steel type with gasketed steel weatherproof cover. Exposed or surface boxes used in or around chemical areas will be equal to the Hubbell Marine rated type.
- B. Wall Switches: Quiet slow make, slow break design, toggle handle, with totally enclosed case, rated 120/277 volt, 20 ampere, heavy duty specification grade. Provide matching two pole, 3-way, 4-way, and key switches as required. Hubbell or Leviton 1221 series. Use Hubbell Marine rated switches in or around chemical areas.
- C. Receptacles: Standard duplex receptacles, full gang size, polarized duplex, parallel blade, U-grounding slot, specification grade, rated at 20 amperes, 125 volts, designed for split feed service. Hubbell or Leviton 5362. Use Hubbell Marine rated devices in or around chemical areas. Ground fault interrupting receptacles shall be Hubbell or Leviton FG5362.
- D. Wall Plates:
  - 1. Provide plate for each wiring device, or as required to protect or cover-up existing conditions left exposed due to the removal of existing devices, conduits, or equipment.
  - 2. Interior Flush: All locations unless noted otherwise; stainless steel (0.35") satin finish, Sierra "S" series.
  - 3. Weatherproof Plates: Cast steel, gasketed. For receptacles, provide spring loaded gasketed doors. Provide at all weatherproof locations. Use Hubbell Marine rated plates in or around chemical areas.

4. Where two gang boxes are required for single gang devices, provide special plates with device opening in one gang and second gang blank.
  5. Blank bushed or special outlet plates shall be provided for all signal and communication systems outlets as required.
- E. Junction Boxes: Use Hoffman fiberglass NEMA Type 4X boxes with single swinging door and quick release catches.

## 2.03 CONDUCTORS AND CABLES

- A. Feeder and Branch Circuit Wire: Copper type THWN/THHN, 600 volt, from new fresh stock, bearing UL label, delivered to site in unbroken packages; minimum size 12 AWG. All 20/1 home runs over 180 feet from panel for 277 volt circuits, and 100 feet from panel for 120 volt shall be increased to next larger size. All conductors shall be stranded copper or as shown on Plans. All control wires shall be stranded and identified by multicolor stripping in a consistent plan of use as submitted by the Contractor and approved by the Engineer and/or the Owner.
- B. High Temperature Wire: NEMA type AF or SFF-2 stranded, for fixture wires and circuit runs within fixtures.
- C. Signal Cables: All millivolt, milliamp, or analog signal cable will be stranded copper with an overall 100% tape shield over conductors and an outer PVC sheath. Run all analog cable(s) in separate conduits keeping as much separation from line voltage conduits as possible. Ground shields at both ends. Minimum separation from line voltage conduits and/or digital control conduits is 6 inches all around.

## PART 3 EXECUTION

### 3.01 INSTALLATION OF CONDUIT RACEWAYS

- A. General: Install conduits in a neat manner, concealed except as noted. Mount conduits directly to building structure with clamps or two-hole straps. Secure straps with cadmium plated wood screws into wood, and machine screws into metal or inserts preset in concrete. Where impractical to secure directly to structure, suspended on conduit hangers (Unistrut or equal supported by cadmium plated rods or allthread. Wherever possible, group and rack multiple conduit runs.
- B. Installation and Cleaning: Install free from dents, kinks and bruises. Plug ends at time of installation to prevent entry of dirt or moisture. Thoroughly clean out conduits before installing conductors. Thoroughly clean all exposed conduit exteriors.
- C. Pull wire: Provide tagged pullwire in all empty conduits. Pullwire shall be 3/16" stranded nylon with a minimum breaking strength of 800 pounds. Leave 36" free coiled each end.

- D. Plastic Conduit: Plastic conduit shall be installed in accordance with manufacturer's recommendations and accepted trade practice. Where plastic conduit runs rise above ground in exposed locations, and for all conduit runs the riser bend and riser shall be of PVC coated galvanized rigid metal conduit installed according to rigid metal portion of this specification section.
- E. Grounding: All conduits shall carry a copper grounding bond wire with the size as shown, or where not shown, as determined by applicable codes for the ampacity of the circuit being carried.
- F. Protective Coating: All metallic conduits installed in contact with earth, or in concrete in contact with earth, shall be coated with a minimum 40 Mil factory applied PVC coating on all conduit lengths and fittings. The coating shall correspond to ATSM D638-68, D1706, D140-64, and D746-64T Specifications and Federal Test Standard 141, Method 615z. Coating shall be continuous without flaws showing exposed metal. Coating shall extend to the device conduit is terminated to in exposed locations and 12" above grade in unexposed locations.
- G. Stub-up Conduits: Conduits which stub-up through floor shall be installed so that none of the curved portion of the elbow is exposed. Where PVC conduits stub up in floor mounted panel boards or junction boxes they will be fitted with a belled end at plus a minimum of ½" from finish floor or pad. Where metallic conduits stub up into floor mounted structures or terminate in electrical boxes they will be fitted with a plastic bushed grounding bushing and bonded to box with minimum #10 AWG bare copper wire. Bushings 2" and over will be bonded with a minimum #8 AWG copper wire.
- H. Conduit Routing: Route exposed conduits parallel or perpendicular to walls or floors. Install conduits in masonry walls at time of wall construction. No conduits shall be run under heavy equipment, footing or other structural elements. Where runs must cross footings, install in sleeves per structural details.
- I. Conduit Runs in Ceiling Areas: Conduits running above accessible ceiling shall be routed parallel or perpendicular to ceiling system and structural members. All conduit runs shall be coordinated to avoid conflicts with mechanical and structural systems, lighting fixtures and ceiling support system. Conduits shall be installed as close to the ceiling structure above as possible to avoid conflict with removal of ceiling panels. Exposed communication, heat detection, security, and energy management cables shall be strapped or attached (minimum every 36") to the ceiling structure above the accessible ceiling. Where cables are run in exposed locations they shall be installed in the appropriate conduit race way system.
- J. Conduits Penetrating Membranes: Where conduits penetrate wall or slab membrane moisture barriers, penetrations shall be sealed.
- K. Conduits Penetrating Roof: Provide flashing and counter flashing making watertight joints where conduits pass through roof or waterproofing membranes.

Where multiple conduits penetrate roof in one location provide appropriate pitch pocket per architectural and/or structural details.

- L. Escutcheons: Conduits (other than in concrete) penetrating wall, floors, or ceiling in exposed locations shall be installed with appropriate stainless steel escutcheon plates.
- M. Separations: Coordinate with all other crafts to allow minimum of 12" running and 6" crossing clearance at flues, hot water pipes, steam pipes, and heat sources. Keep electrical conduits free from contact with all other piping runs of other systems or of dissimilar metals.
- N. Concrete Encased Conduits: PG&E conduits shall be installed per PGE rules and regulations but where under floor slabs they will be capped (4" above top of conduit with concrete colored red. All service entrance conduits under floor slabs shall be capped with 4" above top of conduit with cement colored red.
- O. Conduits Crossing Building Joints: Conduits shall not be run in concrete slab or wall construction where passing through an earthquake or expansion joint. At such condition, conduit shall be run exposed or in furred ceiling space with 24" length of flexible conduit crossing joints.
- P. Conduits Penetrating Floors and Walls: Provide grouting around raceways where penetrating floor slabs, concrete or masonry walls. At fire separation walls or floors, use Engineer approved expanding type Form 3M, or equivalent, to maintain the fire rating of the surface penetrated.
- Q. Conduit Support: Support of conduit and tubing in steel stud walls shall be by #18 gauge steel wire, secured to steel bars or straps attached to steel studs. Conduits rising vertically between wall studs shall be tied to a horizontal cross support attached tightly to eliminate any movement.
- R. Conduits Installed Below Floor Slabs: Conduits shall/will be installed below concrete slab vapor barriers or sand fill by shallow scraping and recovering with earth as required to bury just below surface. Install to minimize disruption to engineered fill. Conduits larger than 1" shall be trenched to a minimum depth of 12" below slab and backfilled and compacted in accordance with the Specifications.
- S. Conduit Hangers:
  - 1. Conduit hangers spaced at 8'-0" on center maximum with one hanger adjacent to each outlet box, shall be installed wherever conduit cannot be directly attached to structure. Hangers shall be secured to wood structures with steel brackets and wood screws; to steel structures with appropriate clamps complete with positive attachment restraining strap or hook rod to prevent slippage; and to concrete structures with preset imbedded inserts or machine screws with expansion shields. Preset inserts are preferred to provide a secure anchorage with greatest location

flexibility. Power or velocity driven type attachments will not be allowed. Complete hanger installation shall provide a safety factor of five (5) based upon maximum NEC allowed conduit fill.

2. Hangers for rigid conduit and EMT 2" and smaller in concealed spaces shall be galvanized perforated type strap wrapped around raceway and bolted; then fastened to structure as described above.
3. Hangers for exposed conduit and tubing suspended below ceilings shall be steel rods 1/4" size for up to 2" and 3/8" for larger size conduits, with adjustable pipe ring; Steel City #C-149, Fee and Mason #199 or #201, or approved equivalent.
4. Trapeze type supports shall be used where conduits are run grouped together. Such hangers shall consist of 3/8" minimum steel rods, structural steel channels, and clamps of Kindorf, Unistrut, or approved equivalent manufacture.
5. Electrical Contractor shall furnish and install concrete inserts, and coordinate location where installing in precast or site poured concrete structures.

### 3.02 INSTALLATION OF EXTERIOR IN-GROUND PULL BOXES AND MANHOLES

- A. Where pull boxes are used without bottoms, they shall be set on 3/4" inches crushed rock of a volume equal to that of the pull box used and bottom and joints grouted water tight with 1/2" drain hole.
- B. Where pre-cast units are used, all joints are to be tongue and groove, sealed with a suitable sealer.
- C. Where conduits enter, they shall be properly bushed and extended a minimum 1" from inside of wall into pull box.
- D. All conduits entering pull boxes and manholes shall be sealed watertight with suitable duct sealing compound. Where metallic conduits are in use they shall be bushed with plastic insulated ground bushings bonded with minimum #8 bare copper wire.
- E. All pull boxes and/or manholes 3' wide by 3' long and over will have a 8' x 3/4" copper clad ground installed in the bottom (grouted water tight) and bonded to all metallic parts with in (plus lid holder) by a #6 solid hard drawn copper wire for 600 volts and under and #4 stranded copper wire for above 600 volts.
- F. All pull boxes and/or manholes will have lid marked as "electrical" for 600 volts and under, "danger high voltage" for above 600 volts, "Telephone" for telephone or communications, "street lighting" for out door lighting circuits, and "control" for control. Where steel lids are used marking will be 1/8" raised welded letters.

### 3.03 INSTALLATION OF OUTLET, JUNCTION AND SWITCH BOXES

- A. **Mounting:** Mount outlet boxes flush in finished areas other than mechanical rooms, electrical rooms, and above removable ceilings. Boxes shall be set true and flush with all necessary and correct adapters and/or plaster rings. All boxes set deeper than code allowable shall be corrected by use of factory made extension rings such as Raco #976 or equivalent. Boxes in wood construction shall be mounted to support with wood screws.
- B. **Device Locations:** Locations of devices on Plans are approximate only. Contractor shall study the architectural and structural plans and locate the outlets so that his work is coordinated with the work of others and the fixtures and devices present a pleasing and symmetrical appearance when installed. The location of outlets centered on any architectural feature shall be exact. Outlet locations may be moved a maximum of 10' from the location shown on the Plans before roughing-in without cost to the District. Switches in relation to door swings and cabinets must be coordinated with architectural drawings. The Contractor shall coordinate with Mechanical Contractor regarding thermostat outlets and other equipment locations.
- C. **Device Height:** The following dimensions for locating wall outlets represent the distance from the finished floor to the center of the outlet, unless noted otherwise:
- Outlets = 12" (except for concrete block walls where height is adjusted to match center of block)
  - Switches = 45" (except for concrete block walls where height is adjusted to match center of block)
  - Over counters where bottom of plate is 2" above back splash.
  - Wall mounted telephone = 60"
  - Access holes through counter tops are minimum 2" with plastic bushing
  - J-boxes are located to serve equipment being served.
  - Outlets and junction boxes for chemical pumps will be 2" above pump mounting shelf to bottom of plate.

Adjust outlet mounting height to agree with required location for equipment served. In areas inclosing process equipment or related systems, the minimum mounting height is 30 inches.

- D. **Exterior Wall Locations:** Conduits shall enter boxes or exterior wall mounted devices at the sides or top only. No conduit shall enter the bottom of such boxes.
- E. **Common Boxes and Alignment:** Devices shown adjacent to each other at the same mounting location shall be gang installed under a common plate, except for outlets of different voltages such as telephone and duplex receptacles. Outlets mounted one over the other, or side by side, shall be in exact alignment, centered on one another.

- F. Sealing: All unused holes or openings in boxes shall be slugged or sealed by an acceptable means.

### 3.04 INSTALLATION OF WIRE

- A. Scope: Provide all wiring for complete electrical work, installed in code conforming raceway. Branch circuit wiring shall be #12 AWG minimum, unless noted otherwise. Insulation shall be THHN or THWN.
- B. Home Runs: Branch circuit conductors shall home run to panelboards or motor control centers in groupings shown on the Drawings. Combining branch circuit home run conductors in single conduits other than that shown shall not be permitted.
- C. Color Coding: shall be strictly adhered to and shall be as follows:
1. Color coding for 120/208-volt systems shall be:
    - A Phase - Black
    - B Phase - Red
    - C Phase - Blue
    - Neutral - White
    - Ground - Green
    - Travelers – Pink
  2. Color coding for 277/480-volt system shall be:
    - A Phase - Brown
    - B Phase - Orange
    - C Phase - Yellow
    - Neutral - Gray
    - Ground - Green
    - Travelers – Lavender
  3. Color coding utilized shall be noted on electrical "as constructed" drawings and shop drawings.
  4. Wires shall be of solid colors in size #6 and smaller. In sizes #4 and larger, the wires shall be black and a 3" width of the appropriate color tape shall be applied around the wire at 12" intervals starting 2" from the termination of the end of the wire.
  5. The color coding for control circuit wires will be as noted on the Plans or as agreed upon with the Electrical Engineer, and will be of a color other than that designated for the phase wires. Where control wires are installed and various colors are used, they shall be noted on them "as constructed" drawings and shop drawings turned in at the completion of the job.

6. Where modifying or renovating systems, color coding shall match existing. Where existing color coding is different than that indicated above, Contractor shall notify the Engineer prior to ordering wire so that a logical system can be agreed upon.
- D. Pulling: Use approved wire pulling lubricant for pulling #4 AWG and larger wire. Oil or grease is prohibited as a conductor pulling lubricant. All conductors #8 and smaller shall only be pulled by hand. Pulling lubricant for conductors over 600 V shall be approved by the conductor manufacturer and/or the Electrical Engineer.
  - E. Splices: Join the conductors securely, both mechanically and electrically using crimp, compression, or pressure type connectors, Scotchlok type. Screw-on type connectors shall be used for wires #10 AWG and smaller. The splice area shall be taped to provide equal or greater insulation than the original. Tape run-back over the original insulation shall extend 3 to 5 overall diameters of the insulated wire. No splices in conductors over 600 V or feeders over #6 AWG permitted. All equipment ground conductors will be spliced only with compression connectors.
  - F. Splice Locations: Splice only in accessible junction or outlet boxes.
  - G. Panel Wiring: Wiring in panel boards, switchboards, and cabinets shall be neatly installed. Wiring shall be grouped, laced or clipped, and fanned out to wiring terminals. Where conductors pass over or around sharp metal projections a minimum 1/8" thick rubber insulation material will be used to protect conductor insulation.
  - H. Identification and Markings: In addition to all other requirements for identification and marking of wires, panelboards, and junction boxes the following shall be strictly adhered to.
    1. The identification of individual wires terminating in junction boxes, circuit breakers, terminal strips, or on control devices shall be done by means of waterproof permanent black ink on plastic Brady label.
    2. Each end of particular feeder or subdistribution class circuits shall be marked as to its phase and point of origination or destination and either voltage line to line in distribution class circuits or voltage to ground in subdistribution class circuit.
    3. Where distribution wires are terminated in distribution panels, they shall be marked by a minimum 1-1/2" square Brady label as to either the point of supply or the point of destination, phase and line voltage.
    4. Where subdistribution wires terminate they shall be marked with the point of origination or point of destination, phase, and voltage to ground. This will include all subdistribution circuits originating from 480/277 volt or

208/120 volt distribution panels serving lighting circuits, receptacle circuits, small power equipment, and small mechanical equipment.

5. All control circuits will be marked at each control panel as to their function and where they terminate.
  6. Where control wires terminate into relays or enclosures or terminal cans remote from the main point of control the wires will be marked as to their function and where they originate.
  7. All associated wiring integral within a control cabinet may be marked with the printed circular wire wrapping at each end.
  8. Where wires are pulled through or looped through a junction box, they shall be marked as to the point of origin and the point of destination. All markings in above ground junction boxes will be via Brady label with indelible ink and all markings on junction boxes or pull boxes below ground level will be by means of 1/4" plastic tape with embossed letters. This plastic tag will circle the wire and both ends stapled together.
- I. Testing: All wires less than 600 volt potential shall be tested with a 600 volt megaohm prior to energization and the readings shall be recorded and handed in with the record drawings at the completion of the project. The tests shall be conducted from phase to phase and from each phase to ground. All conductors over 600 volts will be Hi-pot tested after terminators or splices are made per IEEE standards for voltage transmitted with results recorded of IEEE recommended forms and turned into Engineer for approval before energization.

### 3.05 INSTALLATION OF WIRING DEVICES

- A. Devices shall be securely fastened to outlet box with face flush with plate and bonded to equipment grounding system.
- B. Mount receptacles vertically in appropriate boxes with grounding pin towards floor, except where noted for horizontal installation.

### 3.06 INSTALLATION OF WALL PLATES

- A. Install cover plates on wiring devices. Plates shall be set plumb and flush with finish wall surface. Plates located adjacent to one another shall be exactly the same height.

/// END OF SECTION

## SECTION 16400

### DISTRIBUTION AND GROUNDING

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Furnishing and installation of a complete electrical distribution and grounding system.
- B. Furnish and install motor control center(s) consisting of one or more enclosed vertical sections joined together to form a rigid, free standing assembly as indicated on Drawings and as specified.
- C. Make all connections of power to all equipment along with installation of required disconnecting means. Furnish all electrical disconnects, power supplies, and controls as noted within the electrical plans for equipment, compressors, fans, etc. The Electrical Contractor will make all internal wiring connections as directed, mount all loose electrical equipment, and connect all electrical components to control panels. Furnish all electrical disconnects, power supplies and controls as shown on the mechanical plans.

##### 1.02 RELATED SECTION

- A. Section 16010 – Basic Electrical Materials and Methods

##### 1.03 QUALITY ASSURANCE

- A. Codes and Standards: Comply with requirements set forth by Underwriters Laboratories publication, UL-845, NEMA publication #ICS-2, the National Electric Code, and other applicable codes.

##### 1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's data on service entrance equipment, switchboards, motor control centers and/or individual starters, transformers, panelboards, disconnect switches and grounding components.
- B. Trip Curves: Submit trip timing curves for all circuit interrupting devices.
- C. Nameplate Schedule: Submit nameplate schedule for approval.
- D. Motor Control Center Submittals:
  - 1. Product Data: Submit manufacturer's technical product data to include, but not limited to, the following: Voltage, phase, frequency, horizontal

and vertical bus capacity, short-circuit ratings, main and branch circuit breaker ratings, types of motor starting, types of wiring, sections, panelboards, and transformers.

2. Shop Drawings: Submit layout drawings of motor control centers showing accurately sealed basic equipment sections including, but not limited to, motor starters, controllers, device panels, and circuit breakers. Show spatial relationships of motor control center components to proximate electrical equipment. Clearly differentiate on wiring diagrams those conductors which are factory-installed and those which are field-installed.
3. Maintenance Data: Submit maintenance data and parts list for each motor control center; including "trouble-shooting" maintenance guide.

## **PART 2 MATERIALS**

### **2.01 COMPONENT COORDINATION**

- A. In order to maintain close control and coordinate the various components of the distribution systems, the number of manufacturers shall be kept to a minimum. Equipment manufacturer shall be General Electric, Cutler/Hammer, or Square D. It shall be the manufacturer's responsibility through the Electrical Contractor to coordinate all components of the system in order to ensure systems that will provide maximum protection of equipment and reliable safe operation.

### **2.02 NAMEPLATES**

- A. Laminated engraved phenolic plastic, color coded red for 277/480 volt equipment, black for 120/208 volt equipment, with white letters. Provide for identification of each piece of equipment, switchboards, transformers, panelboards, disconnects and enclosed breakers, motor control centers. A schedule of nameplates shall be included with the shop drawings for approval. Nameplates shall be secured to face where installed and secured with permanent adhesive and two (2) stainless steel self tapping screws.
- B. Each piece of equipment shall be provided with a 2" x 3-1/2" (or as appropriate) nameplate on the front of the door or on the trim, indicating designation and distribution panel and circuit feeding the panel.
- C. Switchboards, distribution panelboards, and all starters and disconnects shall have sub feeders and main breakers marked with 1" x 3" nameplates indicating load served.
- D. All weatherproof disconnects shall be marked with 1" x 3" engraved nameplates indicating the voltage, amps, function, and panelboard or switchboard from which it is fed from, installed per requirements above.

## 2.03 FEEDER CONNECTIONS

- A. Provide cast saddle type bolted lugs, or hydraulically set compression lugs, for all bus connections. Manufacturer shall be Thomas and Betts, Burndy, O-Z Gedney or approved equivalent.

## 2.04 MOTOR CONTROL CENTERS

- A. Manufacturer: Subject to compliance with requirements, provide motor control centers of one of the following: Square D - Model 6, or a General Electric, Furnas, Cutler/Hammer equivalent.
- B. General: Provide motor control centers and ancillary components of sizes, ratings, classes, types, and characteristics indicated; which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, as required for complete installation, and as specified herein.
- C. Motor Control Centers: Provide motor control centers for operation on 480 volts, 3-phase, 3-wire, 60 HZ ground service, or otherwise indicated on Plans; consisting of one or more vertical sections, each with components and spaces as indicated on Plans. Design motor control centers for connection to available faults of not less than 30,000 RMS symmetrical amperes. Provide motor control centers with NEMA Class 2, Type B wiring.
- D. Structure: Provide factory-assembled, dead front, with enclosed vertical sections, as indicated on Plans, fastened together to form rigid free-standing assembly. Unit shall be able to house the horizontal and vertical busses, motor starters, panelboards, circuit breakers, control and distribution transformers and other components and shall be designed to allow for easy rearrangement of components by the purchaser. Construct units for outdoor NEMA type 3R enclosure unless installed in an enclosed room.
- E. Bus System: Construct bus bars of tin-plated copper, braced to withstand faults of 45,000 RMS symmetrical amperes minimum. Provide main horizontal bus with rating as shown on the plans amperes continuous, and vertical bus rating of 300 amperes continuous; and construct vertical bus bars with protective barriers to prevent accidental contact of personnel with bus. Provisions shall be provided for future splicing of additional sections onto either end of motor control center. Provide tin-plated copper ground bus running the entire length at bottom of motor control center. Drill ground bus and furnish lugs as required.
- F. Starter Units: Provide draw-out type, full-voltage magnetic motor starters with circuit breaker type disconnects and auxiliary control devices as indicated on Plans. Enclose and isolate each unit from adjacent units. Design units so that

faults will be contained within compartments; and with 30,000 amperes minimum, RMS symmetrical fault withstandability. Equip with thermal and magnetic overload protection devices for each motor circuit, two (2) on pilot lights, one (1) off pilot light, breaker position switch, H-O-A selector switch, four (4) auxiliary contacts (interchangeable NO to NC), and an individual control transformer. Incoming 120 volt will be fused and meet California OSHA requirements.

- G. Disconnect Operators: Provide external operator handles for switches and circuit breakers. Design handle with up-down motion and with down position indicating OFF. All circuit breaker operators shall include a separate "tripped" position to clearly indicate a circuit breaker trip condition. It shall be possible to reset a tripped circuit breaker without opening the control unit door. A mechanical interlock shall prevent an operator from opening the unit door when the disconnect is in the "on" position. Another mechanical interlock shall prevent an operator from placing the disconnect in the "on" position while the unit door is open. Provisions shall be provided for locking all disconnects in the "off" position with up to three (3) padlocks.
- H. Space: All unused space in the motor control center shall be able to accept future plug-in units. Unused spaces shall be covered by hinged blank doors.
- I. Identification: Provide equipment/system engraved plastic identification nameplates for each section and MCC in whole in accordance with Motor Control Schedule on Drawings and requirements of these specifications. Submit schedule of nameplates for approval.
- J. Finishes: All exterior and interior surfaces shall be properly cleared, primed with a rust inhibiting prime coat. Provide two (2) finish coats of manufacturer's standard color baked-on enamel finish.
- K. Service Sections: Motor control centers to be utilized as service boards shall be constructed in accordance with serving Utility Company requirements; pull section, lugs, meter provisions, etc. Provide with specific grounding provisions as indicated on Plans.
- L. Variable speed drives will be of the variable torque type. They will have a HOA switch and adjustable potentiometer for manual speed set. They will have a LED display that will display all VFD parameters and alarms and a key pad to program drive to fit site use. The VFD will have a 4-20ma input for a follower circuit and a 4-20ma output representing drive running speed. The VFD will have a communication port with 2 wire or 4 wire communication to a programmable logic controller (PLC) for automatic start/stop, control, speed set, and alarming to and through the PLC. The VSD supplier will supply the necessary software, hardware, and/or software drivers or interfaces for the VSD to communicate to and be controlled from the PLC it is connected to. Variable speed drives installed in outdoor enclosures shall be equipped with a panel mount air conditioning unit

capable of maintaining 85°F in enclosure with an ambient temperature of 115°F in direct sunlight.

## 2.05 GROUNDING

- A. Clamps, bonds, etc., suitable and as necessary to provide continuous ground system per Article 250.
- B. Ground Rods: "Copperweld" 3/4" diameter 10' long.
- C. All grounding conductors shall be copper, sizes not less than that required under NEC requirements. All connections will be hydraulically set compression lugs (#8 AWG and larger) on ground busses and compression type for all others. Main ground grid will be connected by thermo set connections or Burndy UL approved ground compression connectors. Main ground grid will be thermo welded to building structural steel where applicable.

## 2.06 MOLDED CASE CIRCUIT BREAKERS

- A. General: Provide factory-assembled, molded case circuit breakers of frame sizes, characteristics, and ratings indicated. Circuit breakers shall be UL listed and meet NEMA Standards Publication AB1. Breakers covered under this specification may be applied in switchboards, panelboards, motor control centers, combination motor starters, and individual enclosures. Circuit breakers shall be manufactured by G.E., Cutler/Hammer, or Square D.
- B. Construction: Construct with over-center, trip-free, toggle-type operating mechanisms with quick-make, quick-break action and positive handle trip indication. Construct breakers for reverse connection capability, mounting and operating in any physical position, and operating in an ambient temperature of 40 degrees C. Two and three-pole breakers shall be common trip. Provide breakers with mechanical screw type removable connector lugs, AL/CU rated.
- C. Operation: Automatic operation of the circuit breaker shall be obtained by means of thermal and magnetic tripping devices located in each pole of the breaker. The thermal device shall provide time-delay tripping on overloads, and the magnetic device shall provide instantaneous tripping on short circuits. The instantaneous magnetic trip shall be adjustable and accessible from the front of the breaker on frame sizes above 100 amperes.
- D. Small Power Secondary Panelboard Breakers: Bolt on construction, Square D NQOB, GE, or Cutler/Hammer equivalent.
  - 1. All single pole 15 and 20 amp shall be UL listed as "Switching Breakers" and carry the SWD marking.

2. Breakers indicated as "GFI" (Ground Fault Interruptive) shall provide UL Class A C 5 milliampere sensitivity ground fault protection integral within the breaker. Single pole GFI breakers shall take no more panel space than a conventional breaker.
- E. Current Limiting Breakers: Provide breakers with current limiting capability as indicated or required to meet system short circuit requirements. Square D I-Limited, GE or Cutler/Hammer equivalent.
1. On high level fault currents, the circuit breaker shall limit peak current and let-through energy and provide a voltage transient-free interruption at near unity power factor. On fault currents below the threshold of limitation, the circuit breaker shall provide conventional overload and short circuit protection.
  2. The unit shall not contain replaceable elements and the limiter shall automatically reset after circuit interruption.
- F. Series Connected Ratings: Where utilized to meet short circuit requirements, combinations for series interrupting ratings shall be recognized by Underwriters Laboratories and shall appear in the Recognized Component Directory under the "Circuit Breakers - Series Connected" product category DKS2. Current limiting circuit breakers shall allow the use of branch circuit breakers with lower interrupting capacities on systems capable of delivering fault currents up to 200,000 rms symmetrical amperes at 480V ac and 100,000 rms symmetrical amperes at 600 V ac.
- G. Solid State Trip Breakers: Main and feeder breakers indicated "SS" shall be solid state trip type with ampere setting adjustment knobs for changing current carrying capability of units, and with ground-fault protection components with external neutral current transformer (CT). Construct with current carrying components isolated from the trip unit and field installed accessories, and with integral trip unit independent of any external power source. Square D ME/NE/PE/SE, GE or Cutler/Hammer equivalent. Provide with Long Time, Short Time, Instantaneous, and Ground Fault Pick up and delay (LSIG) unless indicated otherwise.
- H. Ground Fault Protection: All 1,000 amp or greater 480 volt and "GFI" indicated service breakers shall be furnished with ground fault protection. Protection may be provided by a zero sequence/shunt trip system or solid state breaker with integral GFI. System shall be complete with all required CTs, power supplies, etc., required.

## 2.07 PANELBOARDS

- A. Power and Lighting Panelboards: shall be Air Circuit Breaker bolted type, UL rated for 75 degree C connections, with voltage, phase, breakers, and NEMA rating as specified in panelboard schedules. Panelboards shall be installed flush or surface mounted as indicated. Panelboards shall be installed in code gauge rust

proof (NEMA 3R) steel cabinets with (gasketed) (flush) doors having (3 point vault) (flush) lock(s), all keyed alike, and (two (2) spring loaded trunk catches) (with trim cut square and true).

1. 120/208 Volt Panelboards: Square D type NQOD, Cutler/Hammer or General Electric equivalent.
  2. 277/480 Volt Lighting Panelboards: Square D type NEHB, Cutler/Hammer, or General Electric equivalent.
- B. Power Distribution Panelboards: shall be Molded Case Circuit Breaker type, UL rated for 75 degree C connections, with voltage, phase, breakers, and NEMA rating as specified in panelboard schedules. Panelboards shall be installed flush or surface as indicated. Panelboards shall be installed in code gauge rust proof (NEMA 3R) steel cabinets with (gasketed) (flush) doors having (3 point vault) (flush) lock(s), all keyed alike, and (two (2) spring loaded trunk catches) (with trim cut square and true). Main service panels will always contain a Class C lightning protection device vented to the outside.
1. 277/480 Volt Power Distribution Panelboards: Square D I-line, or a Cutler/Hammer or General Electric equivalent.
  2. Spaces indicated on panelboard schedules are a minimum. Specifically sized spaces shall be provided. When schedules do not designate space frame size, the panelboard shall be supplied with spaces for one (1) three-pole breaker of the largest frame size which can be accommodated, and two (2) three-pole breakers of the next largest frame size which can be accommodated in the scheduled panelboard.
  3. All spaces shall include all required circuit breaker mounting hardware. Any breaker mounting area available after allotment to scheduled or required spaces shall be filled out with all required hardware to mount three-pole breakers up to 225 amp frame size.
- C. Short Circuit Rating: Panelboard and breakers shall have short circuit rating equal to or exceeding that indicated. Rating shall be for each panelboard as a complete integrated unit, tested in accordance with UL Standard UL 67. Panelboards shall be marked with their maximum short circuit current rating.
- D. All interiors shall be completely factory assembled. They shall be so designed that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors, so that circuits may be changed without machining, drilling, or tapping.
- E. Branch circuits shall be arranged using double row construction except when narrow column panels are indicated. A nameplate per Section 2.02 shall be provided listing panel type and ratings.

- F. Unless otherwise noted, full size insulated neutral bars shall be included. Bus bar taps for panels with single pole branches shall be arranged for sequence phasing of the branch circuit devices. Neutral bussing shall have a suitable lug for each outgoing feeder requiring a neutral connection. A ground bus will be included in all panels. All neutral busses will be isolated down stream of the main grounded source panel. All panels will contain a separate equipment ground bus bolted to the can.
- G. Panel boxes shall be at least 20" wide unless otherwise indicated and made from galvanized steel. Provide minimum gutter space in accordance with California Electric Code. At least four (4) interior mounting studs with adjustable nuts shall be provided.
- H. Door hinges shall be concealed. (All locks shall be flush, stainless steel, cylinder tumbler type locks with catches and spring loaded door pulls, keyed alike). Directory frame and card having a transparent cover shall be furnished with each door.
- I. All exterior and interior steel surfaces of the trim shall be properly cleaned and primed with a rust inhibiting phosphatized coating, and finished with a gray ANSI 61 paint. Trims for flush panels shall overlap the box for at least 3/4" all around. Surface trims shall have the same width and height as the box. Trims shall be mountable by a screwdriver without the need for special tools. After installation, trim clamps shall not be accessible when the panel door is closed and locked.
- J. All bus bars shall be copper, sized in accordance with UL standards to limit the temperature rise on any current carrying part to a maximum of 50 degrees C above an ambient of 40 degrees C maximum.

## 2.08 SWITCHBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide switchboards of one of the following:
  - 1. General Electric Company
  - 2. Cutler/Hammer Company
  - 3. Square D Company
- B. General: Except as otherwise indicated, provide switchboards of types, sizes, characteristics, and ratings indicated, which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information.
- C. Auxiliary Components: Where indicated or specified, auxiliary components such as transformers, meters, contactors, controllers, etc., shall be incorporated at the factory. Miscellaneous components such as current transformers, instrument transformers, etc, shall be included as required to form complete and functional systems, whether specifically specified or not.

- D. AC Dead-Front Distribution Switchboards: Provide factory assembled, dead-front, metal enclosed, self-supporting secondary power switchboards, of types, sizes and electrical ratings and characteristics indicated; consisting of panel (vertical) units, and containing circuit breakers of quantities, ratings and types indicated. Provide copper main bus and connections to switching devices of sufficient capacity to limit rated continuous operating temperature rise to 54 degrees F, and 90 degrees F for circuit breaker branches; with main bus and tap connections silver-surfaced and tightly bolted for maximum conductivity. Brace bus for short circuit tresses up to maximum interrupting capacity. Prime and paint switchboard with manufacturer's finish and color.
- E. Enclosures: Construct dead-front switchboards, suitable for floor mounting, with front cable/wire and conduit accessibility. Provide welded steel channel framework, hinge wireway front covers to permit ready access to branch circuit breaker load side terminals. Coat enclosures with manufacturer's standard corrosive resistant finish. NEMA Type 3R construction, unless otherwise noted. Provide in all switch boards a Class C lighting protection unit fused to the main bus and vented to the outside.
- F. Short Circuit Rating: Switchboards shall have integrated short circuit rating meeting the serving Utility Company available, 45,000 AIC minimum; or as indicated on Plans.
- G. Spaces: All Switchboards shall include all required circuit breaker mounting hardware for designated frame size. Any breaker mounting area available after allotment to scheduled or required spaces shall be filled out with all required hardware to mount three-pole breakers up to 225 amp frame size.

## 2.09 AUTOMATIC TRANSFER SWITCHES

- A. Install where called for, as an integral part of the switchboard or in a separate enclosure as shown. Use NEMA 3R when enclosure is exposed to weather. Automatic bus transfer switches will be ASCO, Russell Electric Company, Cutler-hammer, Onan, or Zennith.
- B. The automatic transfer switch ratings shall be as shown on the drawings, 3 pole double throw, solid neutral. The complete switch assembly shall be listed under UL-1008 for use on emergency systems.
- C. The transfer switch shall be double throw, actuated by electrical operators, momentarily energized and connected to the transfer mechanism by a simple overcenter linkage with a minimum transfer time of 400 milliseconds. The time delay between the opening of the closed contacts and the closing of the open contacts shall allow for voltage decay before transfer.
- D. The transfer switch shall allow the motor and transformer loads to be re-energized after transfer with normal inrush current. The transfer switch shall be capable of

transferring successfully in either direction with 70% of rated voltage applied to the switch terminals.

- E. The normal and emergency contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts shall be mechanically locked in position in both the normal and emergency positions without the use of hooks, latches, magnets or springs and shall be silver-tungsten alloy. Separate arcing contacts, with magnetic blowouts, shall be provided on all transfer switches.
- F. The transfer switch shall be equipped with a safe manual operator designed to prevent injury to operating personnel. The manual operator shall provide the same transfer speed as the electrical operator to prevent a flashover from switching the main contacts slowly.
- G. Engine starting contacts shall be provided to start the generating plant should the voltage of the normal source drop below 80% on any phase after an adjustable time delay of 0.5-3 seconds to allow for momentary dips. The transfer switch shall transfer to emergency when 90% of rated voltage and frequency has been reached. After restoration of normal power on all phases to 90% of rated voltage, an adjustable time delay period of zero to 31 minutes (Factory set at 5 minutes) shall delay retransfer to allow stabilization of normal power. If the emergency power source should fail during this time delay period, the switch shall automatically return to the normal source. A test switch shall be included to simulate normal power failure, and pilot lights shall be mounted on the cabinet door to indicate the switch position. Two auxiliary contacts rated 25 amp, 120 volts shall be mounted on the main shaft; one closed on normal, the other closed on emergency. In addition, one set of relay contacts shall be provided to open upon loss of the normal power supply. All relays, timers, control wiring and accessories shall be front accessible. All control wire terminations are to be identified by tubular sleeve-type markers. A bypass switch will be installed to bypass the time delay to transfer to the normal source.
- H. The automatic transfer switch shall include the following accessories:

Accessory

<u>Number</u>	<u>Function</u>
1d	Time delay to override momentary normal source power outages. To delay engine start signal and transfer switch operation. Adjustable 0.5-3 seconds, factory set at 3 seconds.
2d	Time delay relays to control contact transition time on transfer to either source, adjustable 1-300 seconds, factory set at 3 seconds.
3c	Time delay on retransfer to normal. Adjustable 0-31 minutes, factory set at 5 minutes.

- 5a Load test switch to simulate normal power failure (Maintained Type).
- 7 Contact to close on failure of normal source to initiate engine starting or other customer functions.
- 8 Contact to open on failure of normal source to initiate engine starting or other customer functions.
- 9a Green pilot light to indicate switch in normal position.
- 9b Red pilot light to indicate switch in emergency position.
- 14a Auxiliary contact closed in normal position.
- 14b Auxiliary contact closed in emergency position.
- 21 Adjustable relay to prevent transfer to emergency until voltage and frequency of generating plant have reached acceptable limits. Factory set at 90% of rated value.

I. As a precondition for approval, the manufacturer of the automatic transfer switches shall verify that the switches are listed by Underwriters' Laboratories, Inc., Standard UL-1008 with withstand and close-in values at least equal to the interrupting rating of the circuit breaker and/or fuse that is specified to protect the circuit.

J. When coordinated with circuit breakers, the automatic transfer switch shall have the following short circuit withstand capability:

Withstand Capability, (RMS Amps Symmetrical),  
Testing at 480 VAC

Switch Ampere Rating	ATS Coordinated with Molded Case <u>Circuit Breakers</u>
100-150	30,000
225-800	50,000
1000-1600	85,000
2000-4000	100,000

During the Withstand Tests there shall be no contact welding or damage. The tests shall be performed on identical samples without the use of current limiting fused. Oscillograph traces across the main contact shall verify that contact separation has not occurred. Test procedures shall be in accordance with UL-1008 and testing shall be certified by Underwriters' Laboratories or any nationally recognized independent testing laboratory.

## 2.10 DISCONNECTS

- A. Motor and circuit disconnects shall have an Underwriters' Laboratory label and ID label as described in these specifications.
- B. Disconnect switches shall be suitable for area where they are installed, i.e., weatherproof, and shall be rated heavy duty. Use only 600 volt class with proper number of poles. Switches shall be fused unless indicated on Plans. Fuses shall be dual element time delay UL Class RK5 unless otherwise noted.
- C. NEMA 3R enclosures shall be equipped with two (2) spring loaded trunk catches.
- D. Provide all disconnects with an operating handle which has provisions for padlocking in the open and closed positions.

## 2.11 MISCELLANEOUS

- A. Equipment Bases: Provide appropriately sized concrete housekeeping bases (+3½") for all floor-mounted equipment.
- B. Hoisting Lifting Lugs: Provide on all heavy equipment as required to ensure safe hoisting.
- C. Space for Future Protective Device: Provide as indicated on drawings; shall be completely equipped for the future addition of a circuit breaker or fused switch, including all connections.
- D. Keys: All equipment enclosures shall be keyed alike.

## PART 3 EXECUTION

### 3.01 INSTALLATION OF GROUNDING

- A. Provide grounding system complying with the codes and ordinances specified. Grounding system shall provide continuity through the entire electrical system including:
  - 1. Panel board ground buses.
  - 2. All conduit or other raceways.
  - 3. All motors.
  - 4. All lighting fixtures.
  - 5. Grounding terminals of all receptacles and switches.
  - 6. Miscellaneous grounds required by code.
- B. Equipment and raceway bonding procedures shall be rigidly maintained and meet all jurisdictional requirements of codes and regulations.

- C. Good, electrically continuous, metal to metal contacts shall be made wherever possible at all panel boxes, pull boxes, etc. Where it is not possible to obtain good contacts, the conduit shall be bonded around the boxes with a #6 B&S gauge, rubber covered, double braided wire with ground clamps.
- D. A separate grounding conductor shall be run in all conduit runs from all remote devices, distribution, lighting, and power, etc., panel boards, motor control centers and outlets, etc., back to their respective service or distribution panel boards.
- E. A separate grounding conductor shall be run in all branch circuit conduits for all circuits.
- F. Provide a separate grounding conductor in all flexible conduit runs to include watertight flexible conduit with integral grounding straps. Install ground conductors inside conduit with ungrounded conductors. Extend from nearest panel to device being connected.
- G. All new service installations shall be grounded in accordance to code requirements and per plans. Isolated transformers, including mini power zones, shall be grounded on the secondary to a ground rod. If an existing service has not been adequately grounded to a ground rod or metal water piping, then a ground rod shall be installed at the new point of service.
- H. Check resistance to ground at all locations (new and existing services and transformers). If resistance exceeds 25 OHMS, install additional ground rods separated at least 6'-0" until resistance is reduced to 25 OHMS or less (CEC 250-84). Submit results to Engineer.

### 3.02 INSTALLATION OF SWITCHBOARDS

- A. Install switchboards as indicated on house keeping concrete pads, in accordance with manufacturer's written instruction, and with recognized industry practices to ensure that switchboards comply with requirements of NEMA and CEC standards, and applicable portions of NECA's "Standard of Installation."
- B. Prior to energization of circuitry, check all accessible connections to manufacturer's torque specifications. Subsequent to wire and cable hook-ups, energize switchboards and demonstrate functioning in accordance with requirements.
- C. All G.F.I. breakers shall be tested and shown to comply with CEC Section 230-95 in accordance with International Electrical Testing Association, Inc. (NETA) standards by a NETA certified independent testing company.
- D. Panel boards shall have a plastic covered circuit directory card on the inside of each door with all circuit destinations neatly typed. Provide also project name

and date of installation. Switch boards will have engraved plastic name plates as described in these specifications.

### 3.03 INSTALLATION OF DISCONNECTS

- A. Install disconnects for all equipment and motors of the size required and as recommended by manufacturer.
- B. Fuses installed for all mechanical furnished equipment shall be sized and coordinated with Mechanical Contractor for specific motor or equipment requirements.

### 3.04 INSTALLATION OF MOTOR CONTROL CENTERS

- A. Install motor control centers as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that motor control centers comply with requirements of NEMA and NEC standards, and applicable portions of NECA's "Standard of Installation".
- B. Tighten connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standard 486A and B.
- C. Prior to energization of circuitry, check all accessible connections to meet manufacturers torque specifications. Subsequent to wire and cable hook-ups, energize motor control center circuitry and demonstrate capability and compliance with requirements.
- D. Provide equipment grounding connections, sufficiently tight to assure permanent and effective ground, for motor control centers.

### 3.05 EQUIPMENT CONNECTIONS

- A. Installation of Equipment Wiring:
  - 1. Make all connections of power to all mechanical equipment along with installation of required disconnection means. The work is generally as noted, but not specifically limited to the following:
    - a. Pumps
    - b. Process control panels.
    - c. Process motors.
    - d. Transmitting and analyzer equipment and panels.
    - e. Solenoids, control switches, meters, and process items.
  - 2. Supply all electrical junction boxes for mechanical equipment.

B. Motor Connections:

1. The Contractor shall make all line connections for each motor sized as shown on the Plans. Contractor shall be responsible for proper phasing and rotation of all connected motors.
2. The Contractor shall supply those starters indicated on the Plans, install these and Mechanical furnished starters, and make motor-starter connections for all indicated motors.
3. The Contractor shall verify motor characteristics prior to installing wiring. Exact location of motor and motor connections shall be ascertained prior to installing conduits.
4. A flexible conduit connection shall be provided at each motor.

C. Testing: After all wiring to each unit is complete, the Electrical Contractor shall cooperate with Mechanical or Equipment Contractors in testing equipment for proper operation and shall correct wiring as required for proper operation.

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## SECTION 16500

### LIGHTING

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Provide lighting fixtures of sizes, types and ratings as indicated; complete with, but not necessarily limited to, housings, lamps, lamp holders, reflectors, ballasts, starters, wiring, and mounting hardware. Contractor shall be responsible for fixture counts.

##### 1.02 RELATED SECTION

- A. Section 16010 – Basic Electrical Materials and Methods

##### 1.03 FIXTURE DESIGNATION

- A. Unless otherwise shown on the Plans, fixture type designation for an individual fixture shall be typical for similarly indicated fixtures within the entire room or defined area.
- B. Unless otherwise shown on the Plans, fixtures mounted in a continuous row shall be of the same type as any individual designated fixture within the row.
- C. In the event a fixture is undesignated on Plans, it shall be of the same type as fixtures of similar function within rooms or areas.

##### 1.04 COORDINATION

- A. Confirm compatibility and interface of other materials with luminaries and ceiling system. Report discrepancies to the Electrical Engineer, and defer ordering until clarified.
- B. Supply plaster frames, trim rings, and back boxes to other trades.
- C. Coordinate to avoid conflicts between luminaries, supports, fittings, and mechanical equipment.
- D. All fixtures shall be coordinated with the architectural reflected ceiling plan. If any discrepancies occur, the Electrical Engineer must be notified in writing before installation is started.

##### 1.05 SUBMITTALS

- A. Product Data: Submit complete list of fixtures along with manufacturer's catalog

cuts and installation instructions on each type of lighting fixture and component. Include details indicating compatibility with ceiling grid system.

- B. Shop Drawings: Submit layout drawings of all non-standard or customized fixtures. Drawings shall include mounting and feed points and methods.

#### 1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver interior lighting fixtures in factory-fabricated containers or wrappings, which properly protect fixtures from damage.
- B. Store interior lighting fixtures in original packaging. Store inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, laid flat and blocked off ground.
- A. Handle interior lighting fixtures carefully to prevent damage, breaking, and scoring of finishes. Do not install damaged units or components; replace with new.

#### 1.07 SEQUENCING AND SCHEDULING

- A. Coordinate with other work including wires/cables, electrical boxes and fittings, and raceways, to properly interface installation of interior lighting fixtures with other work.
- B. Sequence interior lighting installation with other work to minimize possibility of damage and soiling during remainder of construction.
- C. Order fixtures in a timely manner to allow sufficient time for manufacture and delivery of long lead time items. Make written notification with submittals of any delivery schedule problems. No substitutions will be allowed for late deliveries due to Contractor's lack of coordination.

## **PART 2 MATERIALS**

#### 2.01 ACCEPTABLE MANUFACTURERS

- A. The fixtures described in the Light Fixture Schedule on the Drawings are to be used as a standard of quality to be maintained. Substitute items of same function, performance, and appearance are acceptable in conformance with the Specifications.

#### 2.02 FIXTURES

- A. General: Provide fixtures complete with all fittings, lamps, stems, hangers, and component parts to make a complete installation. Fixtures shall have a suitable interior means of grounding the enclosure.

- B. All fixtures shall bear the UL label and shall be suitable for installation location.
- C. All attaching devices for recessed or surface mounted fixtures mounted in the ceiling shall be of formed or rolled steel and of sufficient strength to prevent movement of fixture after installation.
- D. The Electrical Engineer shall have the right to reject any fixture damaged due to improper packaging. Any fixture with broken or cracked porcelain, broken or bent metal, broken lenses, or an appearance deemed not to be normal, may also be rejected by the Electrical Engineer at the expense of the contractor.
- E. All recessed incandescent and H.I.D. fixtures shall meet the requirements of Article 410 of the National Electric Code.
- F. Lenses shall be virgin acrylic, 0.125 inches thick minimum.
- G. Trademarks or Monograms: There shall be no visible trademarks or monograms on the lighting fixtures.
- H. Recessed Fluorescent Trims: The Electrical Contractor shall use the following fixture trim frame designs.
  - 1. Lay-in Frames: Lay-in frames for all exposed "T" ceiling systems.
  - 2. Flanged Trims: Flanged trims for plasterboard, spline or metal lathe and plaster ceiling systems. Provide plaster or mounting frames where required.

## 2.03 BALLASTS

- A. Unless listed otherwise, fluorescent ballasts shall be "P" rated, HPF - CBM - ETL rated, and bear UL label. Rapid start ballasts sound rating shall be "A" or better. All ballasts shall be Advance Mark III, General Electric, or approved equivalent, energy saving type, equipped with UL recognized component non-PCB-protected capacitors and internal thermal protector to limit ballast case to 90 degrees C.
- B. All HID ballasts shall be high power factor, regulated, potted with no individual fuses, for outdoor use.
- C. Ballasts shall be multi-tap with voltage ratings of 120, 208, 240, and 277 volts.
- D. Ballasts for fixtures located on exterior and within unheated spaces shall be suitable for starting and operation at 0 degrees F.

## 2.04 LAMPS

- A. Lighting fixtures shall be installed complete with lamps as described in schedules and herein.

- B. Fluorescent lamps shall be standard cool white, F35.
- C. Incandescent lamps shall be of the inside frosted long life type, rated 130 volts.
- D. High intensity discharge lamps shall be color corrected, diffuse coated.

## 2.05 EXTERIOR FIXTURES

- A. Metal parts of exterior fixtures exposed to weather conditions shall be constructed of cast or spun aluminum, cast bronze, stainless steel or other nonferrous metals available to withstand exposure.
- B. Steel fixtures installed in damp or wet locations shall have zinc-chromate or equivalent primer.
- C. Provide gaskets on all trims and housings.
- D. Photo Controls: All exterior fixtures not on time clock controlled circuits shall be furnished with integral photoelectric cell.
- E. Standards: Light standards shall be as detailed on Plans. Where painted standards are selected. Electrical Contractor shall provide 2 gallons of matching paint to the District for future touch up work.

## 2.06 WET LOCATIONS

- A. All lighting fixtures installed in wet or damp locations shall have UL approved "wet" or "damp" location labels visible in interior of fixtures.

# PART 3 EXECUTION

## 3.01 INSTALLATION OF LIGHTING FIXTURES

- A. Fixture installation shall conform to all applicable standards for installation, mounting, wiring, and quality.
- B. All fixtures shall be grounded and bonded in accordance with applicable codes. Where fixtures are installed in rows, a bonding screw shall be used to maintain bonding integrity from fixture to fixture.
- C. All fixtures, lenses, and other trim shall be aligned, cleaned, free of paint and blemishes before final acceptance.
- D. Fixtures weighing more than two pounds shall be supported by means other than the outlet box. All outlet boxes shall be able to support a minimum of eight pounds.

- E. For fixtures weighing more than two pounds, support shall be provided at all four corners, plus the outlet box. Each support shall be able to carry a minimum of four times its intended load.
- F. No support or insert, except pendant canopies, shall be visible from the floor.
- G. Where fixtures are pendant suspended, the use of ball aligner and canopies at ceiling and fixture, stem, and other required mounting devices shall be required for installation as required to meet Title 24 requirements. A safety cable anchored to the root structure shall be installed in all pendants.
- H. When fixtures are stem mounted, the variation in distance from the finished floor shall vary no more than ½" from the heights as specified on the Plans.
- I. Mounting Heights: Pendant-Mounted fixtures mounting heights shall be to the bottom of the fixture. Mounting heights of the wall-mounted fixtures shall be to the center of the outlet box unless otherwise noted.
- J. Provide surface-mounted incandescent or fluorescent fixtures with UL approval for direct mounting on the various ceilings, unless specified otherwise. Spacers will not be approved.
- K. Fixtures in Conflict with Ducts and Piping: Electrical Contractor shall coordinate the location of incandescent and fluorescent fixtures to the available space left between the various ducts and piping. Any conflict or adverse situation shall be brought to the attention of the Electrical Engineer.
- L. All fixtures shall be supported from the building structural members or from bridging attached to the structural members. Provide all necessary blocking and hardware so that fixtures hang true, square, plumb, and in proper alignment.
- M. Recessed fixtures in T-bar ceilings shall have a minimum of two #12 steel hanger wires from each fixture to root structure, one at either end, and shall be attached positively to T-bar with locking T-bar clips or metal screws through T-bar into fixture at opposite corners. The attachment device shall have a capacity of 100 percent of the fixture weight acting in any direction (C.A.C. Title 24, Part 2, Section 2-4701, Paragraph Section 47.1813).
- N. Surface fixtures mounted to T-bar ceilings shall be bolted through ceiling panel to metal channel struts suspended between ceiling main runners. Install hanger wires per above from struts to ceiling.
- O. Install flush mounted fixtures properly to eliminate light leakage between fixture frame and finished surface.

- P. Provide plaster frames for recessed fixtures installed in other than suspended grid type acoustical ceiling systems. Brace frames temporarily to prevent distortion during handling.
- Q. All ballasts shall operate within NEMA sound ratings. Noisy or otherwise defective ballasts shall be replaced.
- R. All lamps shall be operating and all fixtures shall be clean at time of final inspection.
- S. Installation of Recessed Fluorescent Fixtures in Accessible-Type Suspended Ceilings: Shall be such that the fixtures will exactly suit the type of ceilings used without altering the fixture or the ceiling. Each fixture shall be wired with a piece of flexible conduit sufficiently long to remove fixture enclosure from ceiling without disconnecting unit. Fixture manufacturer shall prepare drawing or catalog sheets in which all details of fixture installation are carefully analyzed. Contractor to submit these shop drawings for approval. If clearance above "T" bar system is too restricted to "tip-in" fixture, the Electrical Contractor shall coordinate with acoustic ceiling installer by leaving one cross "T" off until the cross "T" shall be secured into its proper place.

### 3.02 FIELD QUALITY CONTROL

- A. Upon completion of installation of interior lighting fixtures, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. The Contractor shall replace at his expense all noisy ballasts, broken or cracked lenses or other defective items. Where possible, correct malfunctioning units at site, then retests to demonstrate compliance; otherwise, remove and replace with new units, and proceed with testing.
- B. At the time of substantial completion, replace lamps in interior lighting fixtures which are observed to be noticeably dimmed after Contractor's use and testing, as judged by Electrical Engineer.
- C. Replace defective and burned out fluorescent or HID lamps for a period of one year following the time of substantial completion.

### 3.03 ADJUSTMENT AND CLEANING

- A. Clean interior lighting fixtures of dirt and debris.
- B. Protect installed fixtures from damage during remainder of construction period.

/// END OF SECTION