# The City of San Angelo

# 2015 Water Treatment Plant Improvement Project

### **Technical Specifications**



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Date: April 22, 2015

**Prepared By** 

The City of San Angelo Department of Public Works Engineering Services Division

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# 4.1 - General Notes

# 4.1.0 Sequencing of Construction

The CONTRACTOR shall prepare and submit to the OWNER within 30 days of the preconstruction conference an in-depth schedule of construction sequencing. CONTRACTOR shall maintain and provide to the OWNER an updated schedule at each progress meeting. Conditions at time of Notice to Proceed and during construction may dictate changes to the schedule.

Sequencing and completion dates, if applicable, for the project shall be as follows:

- 1. Replacement of clarifier drain valves shall be conducted such that only one plant is down for construction activity at any given time. The sequence and duration that each plant is down shall be approved by the OWNER.
- 2. Gravity filter underdrains, media and drain valve replacement shall be conducted such that no more than two filter basins are down for construction activity at any given time.
- 3. Repair of South Filter Gallery Effluent Piping shall be conducted such that the North Filter Gallery is operational throughout construction activities.
- 4. Pipe Gallery painting shall be coordinated to cause minimal disruption to daily plant operations.

CONTRACTOR shall coordinate start-up of various plant equipment and systems a minimum of five working days prior to putting system into operation. CONTRACTOR shall not vacate higher priority location until work is complete at that location.

#### 4.1.2 Underdrain System

Replacement of underdrain caps shall include full removal of existing I.M.S. ® Porous Plate Caps and field installation of new molded thermoplastic I.M.S. ® 200 Media Retainer Caps on the existing Leopold Universal® Type S Underdrain system. Required 3M sealant, screws, grout, etc for mounting shall be included. All exposed rubber air hoses and clamps shall be replaced with new equipment that shall be provided by the underdrains manufacturer.

The following filters and sizes are included in this project:

- Filters 1 thru 4, 6, 13 and 15 (7 filter cells) Each filter cell is 19' x 18'.
- Filters 7 thru 12 (6 dual cell filters (12) total cells) Each cell is 27' x 13'-3".
- Filter 14 (1 filter cell) 27' x 19'.
- The total filter area is 7,200 square feet.

Note – The I.M.S. Cap in Filter #5 has already been removed and replaced with I.M.S. 200 Cap and is not included in this project.

Identification and repair of leaking underdrain bell and spigot joints may be necessary as part of the replacement process. Such identification and repair shall be performed using procedures acceptable to the manufacturer and the OWNER. The unit bid cost for Underdrain Replacement shall include repair of up to 50% of joints per filter at no additional cost to the City.

Removal of backwash troughs to access filters may be required and shall be performed so as to prevent damage existing equipment. Bolts, fittings, etc. shall be replaced with new.

The CONTRACTOR shall have at a minimum three (3) similar installation of Leopold Filter Underdrain Systems within the last five (5) years.

The CONTRACTOR shall have an authorized representative of Leopold present at the site to inspect, check and approve equipment or system installation prior to start-up and to supervise placing the system into operation.

# 4.1.3 Filter Media

Replacement of filter media shall include full removal of existing media and placement of new media in each filter following the placement of new underdrain caps (as appropriate). Approximate filter media quantities are as follows:

Fifteen (15) filters TOTAL FILTER AREA: 7713 square feet

SILICA SAND – 12" Depth plus 1/2" skimming allowance Effective size: 0.45 mm to 0.55 mm Uniformity coefficient: 1.40 8,030 cubic feet 401 Tons

FILTER ANTHRACITE – 30" Depth plus 1" skimming allowance Effective Size: 0.95 mm to 1.05 mm Uniformity coefficient: 1.40 19,925 cubic feet 498 Tons

Materials shall meet and/or exceed American Water Works Association Standard B-100 (latest revision) for Filtering Material. Samples and/or test reports detailing the physical and chemical characteristics of the filtering material shall be provided for review and approval prior to release for shipment.

Material shall be packaged in semi-bulk containers, "Super Bags," with lifting sleeves and bottom discharge spout, containing approximately 3,000 pounds per sack. Any loss of material due to storage or handling shall be replaced by the CONTRACTOR.

# 4.1.4 Valve Actuator Controls

Control panel enclosures for clarifier drain valves shall be 3-point latch, single lever NEMA 4X constructed of 304 stainless steel, minimum 16 gauge material, on new mounting bracket and

stand adjacent to existing concrete slab. Enclosure shall have 90 degree opening door with zero clearance and 180 degree opening with full clearance. Enclosure door shall include data pocket. Enclosure shall have sun shield. Enclosure shall have 110 volt duplex receptacle with weather proof cover flush mounted on the side powered by 30 amp receptacle breaker.

Control panel enclosure shall provide a polished aluminum dead front mounted on continuous aircraft type hinge, containing cutouts for mounting equipment and providing projection of personnel from live internal wiring. Provide cutouts for breaker handles to allow operation of breakers without entering the compartment. Mount control switches, position indicator panels, and other operational devices on the external surface of the dead front. Form a 3/4" break around the perimeter of the dead front to provide integrity.

Include all necessary components for the panel power distribution with stranded copper conductors rated for 90 degrees C. All conductor terminations shall be as recommended by the device manufacturer. Provide indicating type circuit breakers with "on-off-trip" positions of the operating handle. Permanently mark and identify all component parts in the control panel.

### 4.1.5 General Notes

The CONTRACTOR shall develop a method for testing pipe and fittings installed as part of the Work that is will demonstrate leak-free installation and is acceptable to the OWNER. Temporary plugs, flanges, etc. required to perform the Work and testing shall be provided and maintained by the CONTRACTOR.

Structural anchoring systems shall be designed by a licensed engineer in the State of Texas and such systems shall not negatively affect or damage existing components of the Water Treatment Plant.

Implementation and maintenance of trench protection according to OSHA regulations is the CONTRACTOR's responsibility.

The CONTRACTOR shall minimize any dust problems by sprinkling and/or sweeping as directed by the OWNER. Pay is subsidiary to the various bid items. After completing installation and pavement repair of each portion of the project, CONTRACTOR shall thoroughly sweep and clean up all dirt, material and debris from the project area.

The CONTRACTOR will restore all disturbed areas, fences, drives, yards, etc. to original or better condition as approved by the OWNER.

On-Site Storage of Materials: The CONTRACTOR must have the OWNER's approval for onsite storage of materials. Stored materials shall not obstruct the flow of stormwater, vision of vehicle operations, or cause damage to personal or public property. Storage areas shall be kept neat and clean.

City of San Angelo Owned Materials: The CONTRACTOR shall provide all materials to complete the project. The OWNER will not provide materials to the CONTRACTOR unless otherwise specified.

All Concrete shall be 3,000 psi minimum at twenty-eight (28) days unless otherwise specified.

All electrical components of this project shall meet current electrical codes.

# 4.2 - Temporary Facilities

# 4.2.0 General

### 4.2.1 Office at Site of Work

During the performance of this contract, the CONTRACTOR shall maintain a suitable office at or near the site of the Work which shall be the headquarters of his representative authorized to receive drawings, instructions, or other communication or articles. Any communication given to the representative or delivered at the CONTRACTOR'S office at the site of the Work in his absence shall be deemed to have been delivered to the CONTRACTOR. The site office or any other facility at the site shall not be used as a residence.

Copies of the Plans, Specifications, and other Contract Documents shall be kept at the CONTRACTOR'S office at the site of the Work and available for use at all times.

#### 4.2.2 Water

Water in reasonable amounts for proper completion of the Work will be furnished by the OWNER without charge to the CONTRACTOR. The CONTRACTOR shall furnish necessary temporary pipe, hose, nozzles, and tools and shall perform all necessary labor required to connect to existing water facilities. Unnecessary waste of water will not be tolerated. Special hydrant wrenches shall be used for opening and closing fire hydrants. In no case shall pipe wrenches be used for this purpose.

An account of all water usage will be required. OWNER will provide CONTRACTOR with a reasonable amount of water meters, including fire hydrant meters, that shall be used to keep track of water usage during flushing of mains and filling of water trucks. CONTRACTOR shall be responsible to record and report meter readings a minimum of once a month to OWNER.

#### 4.2.3 Power

The CONTRACTOR shall provide all power for heating, lighting, operation of the CONTRACTOR'S plant or equipment, or for any other use by the CONTRACTOR. Temporary heat and lighting shall be maintained until the Work is accepted.

#### 4.2.4 Telephone Service

The CONTRACTOR shall make all necessary arrangements and pay all installation charges for telephone lines in his office at the site and shall provide all telephone instruments.

#### **4.2.5 Sanitary Facilities**

The CONTRACTOR shall furnish temporary sanitary facilities at the site, as provided herein, for the needs of all construction workers and other performing work or furnishing services on the Project.

Sanitary facilities shall be of reasonable capacity, properly maintained throughout the construction period, and obscured from public view to the greatest practical extent. Number of facilities shall be in accordance with federal, state, and local requirements. The CONTRACTOR shall enforce the use of such sanitary facilities by all personnel at the site.

# 4.2.6 Maintenance of Traffic

The CONTRACTOR shall provide OWNER with site specific traffic control plans. The plans shall be prepared by a Professional Engineer, Registered in the State of Texas, and show all necessary control measures in detail to effectively and safely control traffic and pedestrians. Plans shall be submitted to the OWNER.

The CONTRACTOR shall conduct his work to interfere as little as possible with public travel, whether vehicular or pedestrian. Whenever it is necessary to cross, obstruct, or close roads, driveways, and walks, whether public or private, the CONTRACTOR shall provide and maintain suitable and safe detours or other temporary expedients for the accommodation of public and private travel, and shall give reasonable notice to owners of private drives before interfering with them.

#### 4.2.7 Fences

All existing fences affected by the Work shall be maintained by the CONTRACTOR until completion of the Work. Fences which interfere with construction operations shall not be relocated or dismantled until written permission is obtained from the owner of the fence, and the period the fence may be left relocated or dismantled has been agreed upon. The CONTRACTOR shall restore all fences to their original or better condition.

### 4.2.8 Damage to Existing Property

The CONTRACTOR will be held responsible for any damage to existing structures, Work, materials, or equipment because of his operations and shall repair or replace any damaged structures, Work, materials, or equipment to the satisfaction of, and at no additional cost to the OWNER.

The CONTRACTOR shall protect all existing facilities and property from damage and shall provide bracing, shoring, or other work necessary for such protection.

The CONTRACTOR shall be responsible for all damage to streets, curbs, sidewalks, highways, shoulders, ditches, embankments, culverts, bridges, or other public or private property, which may be caused by transporting equipment, materials, or men to or from the Work. The CONTRACTOR shall make satisfactory and acceptable arrangements with the agency having jurisdiction over the damaged property concerning its repair or replacement.

### 4.2.9 Security

The CONTRACTOR shall be responsible for protection of the site, and all Work, materials, equipment, and existing facilities thereon, against vandals and other unauthorized persons.

#### 4.2.10 Access Roads

The CONTRACTOR shall establish and maintain temporary access roads to various parts of the site as required to complete the Project. Such roads shall be available for the use of all others performing work or furnishing services in connection with the Project.

#### 4.2.11 Parking

The CONTRACTOR shall provide and maintain suitable parking areas for the use of all construction workers and others performing work or furnishing services in connection with the

Project, as required to avoid any need for parking personal vehicles where they may interfere with public traffic or construction activities.

# 4.2.12 Noise Control

The CONTRACTOR shall take reasonable measures to avoid unnecessary noise. Such measures shall be appropriate for the normal ambient sound levels in the area during working hours. All construction machinery and vehicles shall be equipped with practical sound muffling devices, and operated in a manner to cause the least noise consistent with efficient performance of the Work.

# 4.2.13 Dust Control

The CONTRACTOR shall take reasonable measures to prevent unnecessary dust. The CONTRACTOR shall limit dust generation by clearing only those areas where immediate activity will take place, leaving the remaining area(s) in the original condition, if stable. Maintain the original cover as long as practicable. Earth surfaces subject to dusting shall be kept moist with water or by application of a chemical dust suppressant and repeat as needed. Water shall be furnished by the CONTRACTOR and shall be clean and free from industrial wastes and other objectionable matter. Do not apply water in quantities to cause runoff. Dusty materials in piles or in transit shall be covered when practicable to prevent blowing.

# 4.2.14 Temporary Drainage Provisions

The CONTRACTOR shall provide for the drainage of storm water and such water as may be applied or discharged on the site in performance of the Work. Drainage facilities shall be adequate to prevent damage to the Work, the site, and adjacent property.

Existing drainage channels and conduits shall be cleaned, enlarged or supplemented as necessary to carry all increased runoff attributable to the CONTRACTOR'S operations. Dikes shall be constructed as necessary to divert increased runoff from entering adjacent property (except in natural channels), to protect the OWNER'S facilities and the Work, and to direct water to drainage channels or conduits. Ponding shall be provided as necessary to prevent downstream flooding.

# **4.2.15 Pollution Control**

The CONTRACTOR shall prevent the pollution of drains and watercourses by sanitary wastes, sediment, debris and other substances resulting from construction activities. No sanitary wastes will be permitted to enter any drain or watercourse other than sanitary sewers. No sediment, debris or other substance will be permitted to enter sanitary sewers and reasonable measures shall be taken to prevent such materials from entering any drain or watercourse.

# **4.2.16 Erosion and Siltation Controls**

The CONTRACTOR shall be responsible for complying with all applicable Local, State and Federal regulations concerning Erosion and Sediment Control. If required, the CONTRACTOR shall prepare and submit all required documentation, including but not limited to, "Notice of Intent" (NOI), "Notice of Termination" (NOT), and "Notice of Change" (NOC). The CONTRACTOR shall prepare and comply with the Storm Water Pollution Prevention Plan and Storm Water Management Plan. The plans shall be prepared by a Professional Engineer, Registered in the State of Texas, and show all necessary control measures in detail to effectively control erosion and sediment. Plans shall be submitted to the OWNER. The CONTRACTOR shall be responsible for all fees associated with the Permit.

The inspection and maintenance of the erosion prevention measures shall be the contractor's responsibility throughout all phases of the construction. All erosion control measures shall be in place prior to any construction activities. They shall remain in place until after construction is complete and the site has been stabilized.

The CONTRACTOR shall provide silt fencing and or erosion control blankets appropriate for erosion and siltation control, and shall maintain all such systems in effective operating condition throughout the entire construction process.

# 4.3 - Excavation and Backfill

# 4.3.0 General

### 4.3.0.1 Scope

This section covers excavation work and shall include the necessary clearing, grubbing, and preparation of the site; removal and disposal of all debris; excavation and trenching as required; the handling, storage, transportation, and disposal of all excavated material; all necessary sheeting, shoring, and protection work; preparation of subgrades; pumping and dewatering as necessary or required; protection of adjacent property; backfilling; pipe embedment; construction of fills and embankments; surfacing and grading pavement replacement, concrete blocking; and other appurtenant work. Excavation shall provide adequate working space and clearances for the work to be performed therein.

Subgrade surfaces shall be clean and free of loose material of any kind when concrete is placed thereon.

Backfilling and construction of fills and embankments during freezing weather shall not be done except by permission of the OWNER. No backfill, fill, or embankment materials shall be installed on frozen surfaces, nor shall frozen materials, snow, or ice be placed in any backfill, fill, or embankment.

### 4.3.1 Classification of Excavated Materials

All excavation shall be "unclassified". Excavation and trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the contract work, regardless of the type, character, composition, or condition thereof.

#### **4.3.2 Site Preparation**

All areas of the site to be occupied by permanent construction or embankments shall be cleared of all trees, roots, brush, and other objectionable materials and debris. All stumps shall be grubbed. Subgrades for fills and embankments shall be cleaned and stripped of all surface vegetation, sod, and surface soils All waste materials shall be removed from the site and disposed of by and at the expense of the CONTRACTOR. Suitable surface soils shall be stockpiled on the site and used for final site grading. Excess surface soils, as determined by the OWNER, shall be removed at the CONTRACTOR`S expense.

# 4.3.3 Blasting

Blasting or other use of explosives for excavation will not be permitted without the written consent of the OWNER.

#### 4.3.4 Unauthorized Excavation

Except where otherwise authorized, shown, or specified, all materials excavated below the bottom of concrete walls, footings, slabs on grade, and foundations shall be replaced, by and at the expense of the CONTRACTOR, with concrete placed at the same time and monolithic with the concrete above. Excess excavation of trenches shall be refilled with material approved by the OWNER.

### 4.3.5 Dewatering

Dewatering equipment shall be provided to remove and dispose of all surface and ground water entering excavations, trenches, or other parts of the work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure to be built, or the pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

All excavations for concrete structures or trenches which extend down to or below ground water shall be dewatered by lowering and keeping the ground water level beneath such excavations twelve inches (12") or more.

Surface water shall be diverted or otherwise prevented from entering excavated areas or trenches to the greatest extent practicable without causing damage to adjacent property.

The CONTRACTOR shall be responsible for the condition of any pipe or conduit which may be used for drainage purposes, and all such pipe or conduit shall be left clean and free of sediment.

All dewatering activities shall be in compliance with the Texas Commission on Environmental Quality (TCEQ) rules and guidelines, i.e. limit erosion, sediment disposal and permitting. All dewatering shall also be in compliance with Technical Specification 4.2.14, "Temporary Drainage Provisions," and Technical Specification 4.2.15, "Pollution Control." of this project specification manual.

#### 4.3.6 Stabilization

Subgrades for concrete structures and trench bottoms shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud and muck; and shall be sufficiently stable to remain firm and intact under the feet of the workmen.

Subgrades for concrete structures or trench bottoms which are otherwise solid, but which become mucky on top shall be reinforced with crushed rock or gravel. The stabilizing material shall be spread and compacted to a depth of not more than four inches (4"). If the required depth exceeds four inches (4"), the material shall be spread and compacted by vibration. The finished elevation of stabilized subgrades shall not be above subgrade elevations indicated on the Plans.

# 4.3.7 Earth Fills and Embankments

Fills and embankments shall be constructed to lines and grades indicated on the Plans.

All material placed in fills and embankments shall be free from rocks or stones larger than four inches (4") in their greatest dimension, brush, stumps, roots, debris, and organic or other deleterious materials and shall be approved by the OWNER.

No rocks or stones shall be placed in the upper eighteen inches (18") of any fill or embankment. Rocks or stones within the allowable size limit may be incorporated in the remainder of fills and embankments provided they are distributed so that they do not interfere with proper compaction.

# 4.3.8 Subgrade Preparation

After preparation of the fill or embankment site, the areas of the subgrade shall be leveled and compacted to ninety-five percent (95%) of modified proctor density as determined by ASTM D1557 at optimum moisture content.

### **4.3.9 Placement and Compaction**

All fill and embankment materials shall be placed in approximately horizontal layers not to exceed eight inches (8") in uncompacted thickness. Material deposited in piles or windows by excavating and hauling equipment shall be spread and leveled before compaction.

Each layer of material shall have the best practicable moisture content for satisfactory compaction. The material in each layer shall be wetted or dried as required and thoroughly mixed to ensure uniform moisture content and adequate compaction. Each layer shall be thoroughly compacted to ninety-five percent (95%) of modified proctor density at optimum moisture content as determined by ASTM D1557. If the material fails to meet the density specified, compaction methods shall be altered.

Wherever a trench is to pass through a fill or embankment, the fill or embankment material shall be placed and compacted to an elevation not less than twelve inches (12") or more than eighteen inches (18") above the top of pipe elevation before the trench is excavated.

# 4.3.10 Granular Fills

Granular fills shall be provided where required. Granular fills shall be placed on suitably prepared subgrades and compacted by vibration. Granular fill material shall be pea gravel, well graded and clean, 2-inch to No.4, meeting all requirements of ASTM C33. Granular fill shall be compacted to eighty percent (80%) relative density as determined by ASTM 2049.

# 4.3.11 Unsuitable Foundation Material

Soft, loose, or otherwise unsuitable foundation soils that occur shall be excavated and removed to the limits designated by the OWNER and replaced with compacted backfill. The compacted backfill shall comply with the requirements specified.

#### 4.3.12 Trench Excavation

Trenches shall be excavated so that pipes can be laid straight at uniform grade, without dips or humps. All fill material shall be in compliance with the utility trench repair details shown in the Plans.

# 4.3.13 Minimum Cover

Where pipe grades or elevations are not definitely fixed by the contract Plans, trenches shall be excavated to a depth sufficient to provide a minimum depth of thirty-six inches (36") of backfill cover over the top of the pipe, including coupling or bells.

# 4.3.14 Limiting Trench Widths

Trenches shall be excavated to a width which will provide adequate working space and sidewall clearances for proper pipe installation, jointing, and embedment. Trench widths from the bottom of the trench to an elevation one-foot above the top of the installed pipe shall be as follows:

Nominal Pipe Size	Minimum Trench Width	Max. Trench width
<=16"	Pipe OD plus 12"	Pipe OD plus 18"
>16"	As specified by pipe manufacture	r and approved by the OWNER

### 4.3.15 Compacted Backfill

Compacted backfill will be required for the full depth of the trench above the embedment in the following locations:

- a) Where beneath surface construction, structures, or streets.
- b) Where in future street right-of-ways.
- c) Where beneath fills or embankments.

Compacted backfill shall be placed in eight inch (8") un-compacted thick layers and compacted at optimum moisture content to ninety-five percent (95%) modified proctor density as determined by ASTM D1557. Where the trench for one pipe passes beneath the trench for another pipe, backfill for the lower trench shall be compacted to the level of the bottom of the upper trench. The CONTRACTOR shall be responsible for providing all proctor data from all source pits to be used, as approved by the OWNER. The OWNER reserves the right to conduct density tests at any time, at the OWNER's expense.

Trench areas not required to have compacted backfill, shall be backfilled and stabilized by the water jetting method. Material shall be deposited in the trench in layers not exceeding two feet (2') thick. A water jet pipe shall be inserted at close intervals on opposite sides of the pipe and the material shall be adequately soaked so it will consolidate in the trench. Jetting methods shall be approved by the OWNER. Backfill not suitable for water jetting shall be placed by methods approved by the OWNER. Completed backfill shall be neatly rounded over the trench.

Where well pulverized or granular material is available from the trench excavation, which meets the approval of the OWNER for Backfill, the CONTRACTOR will be allowed to use the approved material from the excavation for Backfill as instructed by the OWNER.

#### 4.3.16 Structure Backfill

The quality and moisture content of materials for backfill around and outside of structures shall conform to the requirements for materials used for trench backfill. Backfill materials shall be deposited in layers not to exceed eight inches (8") in uncompacted thickness and compacted to at least ninety-five percent (95%) of modified proctor density at optimum moisture content as determined by ASTM D1557. Compaction of structure backfill by rolling will be permitted provided the desired compaction is obtained and damage to the structure is prevented. Water jetting of structural backfill shall be allowed only upon permission of the OWNER.

No backfill shall be deposited or compacted in water. Particular care shall be taken to compact structure backfill which will be beneath pipes, surface construction, or structures. In addition, wherever a trench is to pass through structure backfill, the structure backfill shall be placed and

compacted to an elevation not less than twelve inches (12") above the top of pipe elevation before the trench is excavated. Compacted areas, in each case, shall be adequate to support the item to be constructed or placed thereon.

# 4.3.17 Final Grading and Placement of Topsoil

After other outside work has been finished, and backfilling and embankments completed and settled, all areas which are to be graded shall be brought to grade at the indicated elevations, slopes, and contours. All cuts, fills, embankments, and other areas which have been disturbed or damaged by construction operations shall be surfaced with topsoil to a depth of at least four inches (4"). Topsoil may consist of the surface soils cleared from the site during site preparation and shall be of a quality at least equal to the existing topsoil in adjacent areas, free from trash, stones, and debris, and well suited to support plant growth.

Use of graders or other power equipment will be permitted for final grading and dressing of slopes, provided the result is uniform and equivalent to hand work. Unless otherwise indicated, a slope of at least one percent shall be provided.

Final grading and surfacing shall be smooth, even, and free from clods and stones larger than one-inch in greatest dimension, weeds, brush, and other debris.

# 4.3.18 Disposal of Excess Excavated Materials

Insofar as needed, suitable excavated materials shall be used. All excess excavated materials together with all debris stones, stumps, and roots shall be removed from the site and disposed of by, and at the expense of, the CONTRACTOR. Excess material or material which cannot be made suitable for use in embankments will be declared surplus and shall become the property of the CONTRACTOR to dispose of offsite at a permitted fill site, without liability to the OWNER or any individual. Such surplus material shall be removed from the Work site promptly following the completion of the portion of the utility involved.

# 4.3.19 Shoring and Sheathing of Excavations

Wherever necessary to prevent caving, excavation shall be adequately sheeted and braced. Where sheeting and bracing are used, the trench width shall be increased accordingly. Trench sheeting shall remain in place until the pipe has been laid, checked for defects and repaired if necessary and the trench backfilled to a depth of two feet (2') over the top of the pipe. The CONTRACTOR shall comply with all local, state and federal requirements for sheeting and shoring.

# 4.3.20 Settlement

The CONTRACTOR shall be responsible for all settlement of backfill, fills, and embankments which may occur within the correction period stipulated in the General Conditions.

The CONTRACTOR shall make, or cause to be made, all repairs or replacements made necessary by settlement within thirty (30) days after notice from the OWNER.

# 4.3.21 Pavement Replacement

Pavement surface, concrete, caliche, limestone, or asphaltic, replacement shall be done by the CONTRACTOR at his expense as indicated on the Plans.

# 4.3.22 Concrete Blocking

Concrete blocking shall be placed at bends, tees, wyes, crosses, plugs, hydrants, etc., in the water line. The concrete blocking shall be placed so as to rest against firm undisturbed trench walls. The supporting area for each block shall be sufficient to withstand the thrust, including water hammer. Each block, except those for upward thrusts, shall rest on a firm, undisturbed foundation of trench bottom. Where upward thrusts are to be blocked, the concrete blocking shall be of sufficient weight to resist the thrust and the concrete shall be reinforced as directed by the OWNER. Blocking shall not extend beyond any joints, cover any bolted connections or in any way restrict or inhibit the access to or workability of any component of the water line.

### 4.3.23 Measurement and Payment

All work and material furnished under this section is considered subsidiary to the various pay items; therefore, no additional payment shall be made for material furnished or work done under this section.

# 4.4 - Trench Safety Systems

# 4.4.0 General

#### 4.4.0.1 Scope

This section shall govern for designing, furnishing, installing, maintaining and removal of Trench Safety Systems for trench excavation. Back-sloping and/or benching of the trench are not acceptable means of trench protection unless prior approval is obtained from the OWNER.

At a minimum, this work shall conform to the United States Department of Labor Rules 29 CFR, Part 1926 Occupational Safety and Health Administration (OSHA). The Competent Person(s) shall be on the project whenever workers are in an excavation trench.

Attention is called to the fact that excavations may contain potentially harmful environments or atmospheres. If working on or around the sanitary sewer system it has the capability of producing an environment that may be harmful to workers. The CONTRACTOR shall provide workers with personal protective equipment as necessary to provide adequate protection. The CONTRACTOR shall provide equipment to determine if a hazardous atmosphere exists prior to allowing workers to enter any areas that may contain a potentially harmful environment. The equipment shall be kept calibrated, maintained in good condition and all maintenance and calibration records kept on site for inspection.

At a minimum, the CONTRACTOR shall monitor and record atmosphere testing results for oxygen levels and the presence of combustible gases. These measurements should be made before lids are removed and shall be measured at various depths including the workspace. Testing shall continue as long as workers are present in the area.

# 4.4.1 Trench Safety System Plan Submittal

Prior to, or at the Pre-Construction Meeting, the CONTRACTOR shall submit to the OWNER a Trench Safety System Plan sealed by a registered Professional Engineer licensed in the State of Texas. The Trench Safety System Plan at a minimum shall conform to OSHA standards for sloping sides, utilization of trench boxes, and/or utilization of shoring, sheeting and bracing methods. The CONTRACTOR shall be responsible for obtaining all information necessary for the design of the Trench Safety System Plan. The Trench Safety System Plan submittal shall include:

- a) A drawing or plan indicating specific designation of areas in which each type of system will be used, including length of trench to be opened, the length of time that trench will remain open, the means of egress, the storage of materials, allowable loads of trench walls, the methods for placing/compacting bedding/backfill within the safety system, any equipment restrictions and the subsequent removal of system,
- b) Drawings or manufacturer's data, as applicable, that describes the various elements of the Trench Safety System in sufficient detail that the workers can properly install the Trench Safety System,
- c) Recommendations and limitations for using systems.
- d) Certification of Completion of an OSHA-approved program indicating that the CONTRACTOR's Competent Person(s) has received training in "Excavation Safety".

# 4.4.2 Construction

The CONTRACTOR's Competent Person(s) shall be responsible for the maintenance of a copy of appropriate OSHA regulations onsite and the implementation of OSHA trenching safety regulations at the work site. Trenching shall be completed to the lines and grades indicated on the Plans or as specified in various technical standard specification items requiring excavation and trenching and/or backfilling. The CONTRACTOR shall perform all trenching in a safe manner and shall maintain safety systems to prevent death or injury to personnel or damage to structures, utilities or property in or near the excavation.

If evidence of possible cave-ins or earthen slides is apparent or an installed trench safety system is damaged, the work in the trench shall immediately cease and personnel evacuated from the area. Personnel shall not be allowed to re-enter the excavation until necessary repairs or replacements are completed and are inspected and approved by the CONTRACTOR's Competent Person(s). Repair and/or replacement of the damaged safety system shall be at the CONTRACTOR's sole expense.

### 4.4.3 Changed Conditions

When changed conditions require modifications to the Trench Safety System, the CONTRACTOR shall provide to the OWNER a new design or an alternative Trench Safety System that is proposed by the CONTRACTOR's Trench Safety Engineer to address the changed conditions encountered. Copies of the new design or alternate system shall be provided to the OWNER in accordance with the requirements of Technical Specification 4.4.1, "Trench Safety System Plan Submittal". A copy of the most current Trench Safety System shall be maintained on site and made available to inspection and enforcement officials at all times.

Any changes to the Trench Safety System Plan that are initiated by the CONTRACTOR for operational efficiency or as a result of changed conditions will not be cause for cost adjustment.

# 4.4.4 Contractor's Responsibility

The CONTRACTOR has sole and exclusive responsibility for the sufficiency of the trench excavation safety systems utilized conforming fully to all State and Federal laws applicable inclusive of the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) on excavation, trenching and shoring, which includes, but is not limited to, Subpart P, Part 1926, of the Code of Federal Regulations.

The CONTRACTOR shall specifically agree that neither the OWNER nor the Engineer nor any representative has such responsibility, and CONTRACTOR will not rely on the OWNER or the Engineer or any of their representatives for inspection, design, supervision, construction or any other aspect of trench excavation safety protection.

#### 4.4.5 Measurement and Payment

All work and material furnished under this section is considered subsidiary to the various pay items; therefore, no additional payment shall be made for material furnished or work done under this section.

# 4.10 - Valves and Valve Installation

# 4.10.0 General

#### **4.10.1 Section Includes**

- a) Resilient Seat Gate Valves
- b) Butterfly Valves
- c) Valve Operations
- d) Gate Valves and Ball Valves
- e) Air Release Valves

### 4.10.2 General Description

Valves which are to be installed shall be the types and sizes and at the locations indicated on the Plans. Butterfly valves shall conform to AWWA C504, Class 150B and have an integral ISO 5211/MSS SP-101 pad for direct mounting of actuator, and resilient seat gate valves shall conform to AWWA C509 with capability for direct mounting of actuator. All valves and fittings shall be 150 psi working pressure or better, unless otherwise specified in the Contract Documents. All valves shall turn counterclockwise to open. Unless otherwise shown on the Plans or directed by the OWNER, all valves shall be installed in the vertical position. Valves shall be equipped with slip-on, mechanical, or flanged joints suitable for use with the pipe on which they will be installed. Where practicable, valves installed underground shall be mechanical joint or slip-on, and valves installed above ground shall be flanged. All valves shall be furnished with the necessary bolts, nuts, glands, gaskets, and other accessories necessary for their complete installation. All manual operated valves shall have a two inch (2") square wrench nut and valves larger than four inch (4") shall be equipped with Worm Gear for operation unless otherwise specified.

It is the intent of these specifications that all valves, valve boxes, and accessories furnished under this Contract shall be of the best quality for the use of purpose intended, and all materials incorporated shall meet the requirements of the service intended, regardless of the pressure specified for the valve.

All valves shall be fully supported by cast-in-place concrete or valve stands. The concrete shall be placed on firm, undisturbed soil. The pipe and fitting joints shall remain accessible for repair. The minimum depth of concrete for valve foundations shall be six inches (6") for twelve inch (12") valves and smaller and shall be eight inches (8") for valves larger than twelve inches (12"). Reinforcement shall consist of 4x4 W2.9xW2.9 (6 gauge) or approved equal. The concrete shall extend a minimum of four inches (4") beyond all contact points with the valve.

#### 4.10.3 Resilient Seat Gate Valves

All valves four inches (4") through thirty-six inches (36") shall be non-rising stem resilient seat gate valves, unless otherwise shown on the Plans or directed by the OWNER, as manufactured by American Darling, East Jordan Iron Works, J&S, Mueller, M & H or U.S. Pipe. The valves shall be tested for zero leakage past the seat at 200 psi and hydrostatically shell tested at 400 psi. The valves shall be wedge disc type and shall contain a machined surface in the valve body

with solid guide lugs on the disc that travel within channels cast in the sides of the valve. The valve shall contain a bronze stem nut and O-ring seals above and below the thrust collar with a thermoplastic anti-friction washer above the thrust collar. Interior and exterior of the valve shall be epoxy coated, 8 millimeters, dry film thickness, minimum. For each valve eighteen inches (18") and larger, the manufacturer shall provide an affidavit of compliance to demonstrate compliance with AWWA C509. Results of the Shell and Seat Tests shall be included with each affidavit. The affidavit shall demonstrate that the valves are of recent manufacture and that the valves have been tested within ninety (90) days of receipt. The CONTRACTOR shall operate each valve prior to installation to ensure free and proper functioning. During the operation, the CONTRACTOR shall allow the OWNER the opportunity to visually inspect and to operate the valves.

Resilient seat gate valves twenty inches (20") and larger shall be supplied with spur gear operators installed by the valve manufacture, unless otherwise specified on the Plans.

# 4.10.4 Butterfly Valves

Butterfly valves shall be solid shaft type 304 SS extending through the body and meeting AWWA C504, as manufactured by DeZurik, Clow, GA Industries, Mueller or Pratt. All keys and pins used in securing valve discs to shafts shall be stainless steel. Valve body shall be high-strength cast iron ASTM A126 Class B or ASTM A536 Grade 65-45-12 ductile iron with 18-8 Type 304 stainless steel body seat. Valve vane shall be high-strength cast iron ASTM A48 Class 40, having rubber seat mechanically secured with integral 18-8 stainless steel clamp ring or SS pins and 18-8 stainless steel nylon locked screws forming a leak-tight joint. Valve disc shall have SS3 316 seat edge and seat made from Buna-N that shall seal tightly agains full rated differential pressure. Valve seats shall be 18-8 stainless steel. Shaft seals shall be O-ring type. The interior and exterior of the valve shall be NSF-61 Certified epoxy coated, 6-8-mil dry film thickness, minimum, per AWWA C550.

# 4.10.5 Valve Bodies

- a) Clear Water Opening: The diameter of the clear waterway opening through the valve shall be not less than the rated size of the valve.
- b) Flanges: Flanged valves shall meet the AWWA C504 "short body" face-to-face dimension and be faced and driller per ANSI B16.1. Flanges shall be furnished to true plane surfaces within a tolerance limit of 0.005 inch; the finished face shall be normal to the longitudinal valve axis within a maximum angular variation tolerance of 0.002 inch per foot of flange diameter.
- c) Mechanical Joint Ends: Where mechanical joint ends are specified, either mechanical joint or push-on ends conforming to ANSI A21.11 will be acceptable.

# 4.10.6 Valve Operations

Operator mounting arrangements and handwheel positions shall be as indicated on the Plans or as directed by the OWNER.

# 4.10.6.1 Manual Operations

Unless otherwise required by the OWNER, the direction of rotation of the wheel or wrench nut to open each valve shall be to the left (counterclockwise). Each valve body or operator shall have cast thereon the word OPEN and an arrow indicating the direction to open.

Hand-wheel diameter shall be at least eight inches (8") but not more than twenty-four inches (24") for thirty inch (30") or smaller valves.

Wrench nuts shall be standard AWWA wrench nuts as described in Section 4.16 of AWWA C500.

# **4.10.6.2 Electrical Operations**

Electric actuators shall be open / close or full modulating as indicated on the Plans or directed by the OWNER, as manufactured by Limitorque or Rotork.

Actuators shall have 4-20 mA input for position instruction and 4-20 mA transmission for position indication as well as discrete indicators for open / close status. Position indication shall be in percent (%) open or closed. Valve shall be equipped with open / close buttons and position indicators panels on the valve for local controls. Valve shall be operable by indicating position (% open, close, open), as appropriate, and by pulse input in both local and remote modes. Hand-wheel override operator shall be included for manual operation. Actuator close speed from full open to full close shall not be less than 3 minutes nor more than 15 minutes. Power supply shall be 110 Volt single phase, 60 HTz.

# 4.10.7 Gate Valves and Ball Valves

Unless otherwise shown or specified, all two inch (2") valves shall be all brass, non-rising stem gate valves as manufactured by James Jones. Valves smaller than two inches (2") shall be brass ball valves as manufactured by James Jones.

#### 4.10.8 Valves Boxes

All buried valves shall be provided with valve boxes. Valve boxes shall be cast iron, extension sleeve type, suitable for the depth of cover required. Valve boxes shall be not less than five inches (5") in diameter, shall have a minimum thickness at any point of 3/16-inch, and shall be provided with suitable cast iron bases and covers. Covers shall have cast thereon designation of the service for which the valve is used.

Valve and valve boxes shall be set plumb. Each valve box shall be placed directly over the valve it serves, with the top of the box brought flush with the finished grade. After being placed in proper position, earth shall be filled in around each valve box and thoroughly tamped on each side of the box.

# 4.10.9 Air Release Valves

Air release valves shall be provided and installed by the CONTRACTOR at the locations as noted on the Plans. The air release valves shall be as specified on the Plans, or approved equal. Valve boxes shall be constructed as detailed on the Plans.

#### 4.10.10 Drawings and Data

Complete drawings, details, and specifications covering the valves, actuators and their appurtenances shall be submitted in accordance with the submittals section.

### 4.10.11 Installation

For underground installations, valves shall be carefully lowered into position to prevent damage to any part of the valve. Place the valve in the proper position with stem truly vertical and securely hold until connections have been made. Furnish all bolts, nuts, gaskets and any other required hardware. The CONTRACTOR shall adjust the valve boxes to the proper length to conform to the finished or planned ground surface elevation. The CONTRACTOR shall provide a firm foundation for each valve. The firm foundation shall consist of compacting the sub-grade and placing minimum of six inches (6") of concrete with #3 rebar centered each direction. All sub-surface valves shall be wrapped in polyethylene sheeting of approximately 8 mil thickness. Wrapping shall precede concrete placement.

### 4.10.12 Measurement and Payment

Measurement and payment for this item will be based on the lump sum price bid. Payment will include full compensation for installation of valve, actuator, wiring, set-up, etc. in accordance with the specifications, Plans and /or instructions of the OWNER.

# **4.11 - Pressure Pipe Testing and Disinfection**

# 4.11.0 General

### 4.11.0.1 Scope

During the constructing operations utmost care shall be taken to see that parts of structures, inside of pipes, fittings, jointing materials, valves, etc., the surfaces of which will come in contact with the potable water, are maintained in a sanitary condition. Under no circumstances shall any part of a new line be placed in service prior to sterilization.

### 4.11.1 Testing

All new pressure lines shall be tested by the CONTRACTOR with a hydrostatic test pressure of 150 pounds per square inch. The test period shall be four (4) hours for sixteen inch (16") pipe and smaller and twenty-four (24) hours for pipe sizes greater than sixteen inches (16"). Any items found to be defective shall be removed and replaced by the CONTRACTOR and retested after repairs are completed. In order to determine the quantity of water lost through leakage in a section of pipe under the required test pressure, the CONTRACTOR will be required to measure all water used in the pressure test through an approved meter. The maximum leakage permitted on the basis of 150 pounds per square inch shall not exceed thirty (30) gal./inch dia./mile/day for asbestos cement pipe, ten (10) gal./inch dia./mile/day for PVC and ductile iron pipe, and fifty (50) gal./inch dia./mile/day for pre-tensioned concrete cylinder pipe.

The CONTRACTOR will be required to correct defects and bring the leakage within the specified limits before the contract is accepted by the OWNER. Permanent pavement shall not be placed over any pipe until all leakage tests on the section of pipe involved have been completed.

The cost of testing and finding the leaks, repairing and retesting, shall be at the expense of the CONTRACTOR.

#### 4.11.2 Chlorination

When the entire pipe line or selected sections thereof have been completed, tested and are ready for turning over to the OWNER for use, the line or section shall be disinfected according to the following procedure:

- a) A chlorinating material approved by the OWNER shall be injected at one end of the line, and water released from the opposite end until the coloring is present at the discharge end in such quantity to indicate a residual of fifty (50) parts per million (ppm). All valves shall then be closed, and the solution shall remain in the line for at least twenty-four (24) hours. All valves in the lines being sterilized shall be opened and closed several times during the contact period. The CONTRACTOR shall make all necessary taps into the pipe to accomplish chlorination of a new line.
- b) After twenty-four (24) hours, the solution shall be discharged from the line and flushed by water direct from the City of San Angelo main until the residual chlorine content is approximately the same as treated City of San Angelo water.

c) A water sample shall be taken from a suitable tap (not through a fire hydrant) under the supervision of the OWNER for analysis. If the tests show a satisfactory quality of water, the line may be placed into service. If the sample shows an unsatisfactory quality of water, the process of disinfection shall be repeated until a satisfactory sample is obtained. At least one satisfactory sample shall be obtained for every 1,000 feet of new line.

### 4.11.3 Water Service

Before any existing water service is interrupted, or before any existing valves are operated, the OWNER shall be notified and shall be present when such operation is made.

#### 4.11.4 Measurement and Payment

All work and material furnished under this section is considered subsidiary to the various pay items; therefore, no additional payment shall be made for material furnished or work done under this section.

# 4.12 - Ductile Iron Pipe and Fittings

# 4.12.0 General

### 4.12.0.1 Section Includes

This section covers the furnishing and installing of all ductile iron pipe and fittings. The Plans show the general arrangement of all pipes and fittings; however, the responsibility for furnishing exact lengths of the various pipes for proper "make-up" rests with the CONTRACTOR. The ductile iron pipe and fittings shall be 250 psi working pressure or better, unless otherwise specified in the Plans or Contract Documents.

#### 4.12.1 Material Specifications

All ductile iron pipe and fittings shall be manufactured in accordance with the various applicable specifications as listed below. Each length of pipe shall be clearly marked with the manufacturer's trade name, the size and class, and the specifications that it meets. Cast iron fittings are an acceptable alternate to ductile iron. The pipe and fittings furnished shall comply in all respects to the following American National Standards Institute Specifications:

- Pipe Properties and Materials ANSI A21.51 (AWWA C151)
- Cement Lining ANSI A21.4 (AWWA C104)
- Joint Detail ANSI A21.50 (AWWA C151)
- Fittings ANSI A21.10, ANSI A21.53 or ANSI B16.1 (AWWA C110, C153 and C111)
- Installation ANSI (AWWA C600)

Unless otherwise specified on the Plans or elsewhere in the Contract Documents, above ground joints shall be flanged, sub-surface joints shall be compression.

# **4.12.2 General Installation**

Pipe, fittings and specials are to be installed at the line and grade shown on the Plans and as specified in these Contract Documents. Unless otherwise specified in the Plans or directed by the OWNER, the CONTRACTOR shall commence his work with a connection to an existing main carrying water or air and shall carry on his work progressively from such connection, and as each section of line is completed shall turn the line into service at the direction of the OWNER.

# 4.12.3 Pipe Handling

All pipe, fittings, and special casting shall be lowered into trench by suitable machinery and shall not be rolled or dumped into the trench. Pipe and fittings shall be handled in such a manner as not to damage the coating. Before lowering and while suspended, each piece of pipe shall be rung with a light hammer to detect flaws, and any unsound pipe shall be rejected. All dirt and trash that may be on the spigot or in the bell shall be removed while the pipe is suspended. Any pipe that has been contaminated with dirt, mud, debris, etc. shall be removed and replaced or cleaned to the satisfaction of the OWNER. All pipe and fittings shall be handled and lowered into the trench with slings. The use of hooks for handling pipe and fittings will not be permitted.

Where it becomes necessary to deflect the pipe to avoid obstructions, the deflection of each joint must be approved by the OWNER and shall be within acceptable limits of the manufacturer. The pipe is to be kept clean during the laying operation and free of all sticks, dirt, trash, water, insects, and rodents. At the close of each operating day the open end of the pipe shall be effectively sealed with a water and air tight plug. Any pipe section that becomes contaminated shall be removed and replaced unless a method to clean the pipe is approved by the OWNER.

# 4.12.4 Mechanical Joints

The CONTRACTOR shall wire brush and thoroughly clean the surfaces with which the gasket comes in contact on the bell and spigot. The cleaned surfaces of the bell and spigot shall then be lubricated with a nontoxic vegetable soap lubricant suitable for use in a potable water system just prior to slipping the gasket over the spigot end and into the bell. The follower ring shall then be bolted into compression against the gasket. The gland shall be tightened toward the flange, maintaining approximately the same distance between the gland and the face of the flange at all points around the socket. If effective sealing is not attained at the maximum torque recommended by the manufacturer, the joint shall be disassembled and reassembled after thorough cleaning. Over stressing of bolts to compensate for poor installation practice will not be permitted.

# 4.12.5 Slip-on Joints

Slip-on type joints shall be made in the following manner. The gasket and the gasket seat inside the bell shall be wiped clean of all extraneous matter. The gasket shall be placed in the bell in the position prescribed by the manufacturer. A thin film of nontoxic vegetable soap lubricant shall be applied to the inside of the gasket and the outside of the spigot prior to entering the spigot into the bell. The spigot shall be forced home in the bell by use of a crow bar or a fork tool on sizes four inches (4") through eight inches (8"), or by use of a jack on sizes ten inches (10") and larger. When using a field cut plain end piece of pipe, the outside cut end of the pipe shall be tapered about 1/8-inch back at an angle of thirty degrees ( $30^\circ$ ) with a portable grinder or a coarse file before making up the joint.

# 4.12.6 Flanged Joints

Flanged connections shall be made by means of erection bolts and drift pins without undue forcing and with no restraint on the ends of the pipe or fitting which would prevent pressure from being evenly and uniformly applied to the gasket. The pipe or fitting must be free to move in any direction while bolting. Bolts shall be gradually tightened, each in turn, at a uniform rate around the entire flange. Flange bolts shall be installed with all bolt heads in one direction.

# 4.12.7 Blocking

For lines carrying water, concrete blocking shall be placed at bends, valves, tees, crosses and plugs in the pipe lines. The concrete blocking shall be placed so as to rest against firm, undisturbed trench walls, normal to the thrust. The supporting area for each block shall be at least as great as that indicated on the Plans or directed by the OWNER and shall be sufficient to withstand the thrust, including water hammer which may develop. The blocking shall, unless otherwise directed, be placed so that the pipe and fitting joints will be accessible for repair.

# 4.12.8 Wrapping of Ductile Iron Pipe and Fittings

All sub-surface pipe and fittings shall be wrapped in two (2) layers of linear low-density polyethylene (LLDPE) film with a minimum thickness of eight millimeters (8mm). Wrapping shall precede placement of any required concrete (blocking, etc.). LLDPE film and installation shall meet the requirements of ANSI/AWWA C105/A21.5.

# 4.12.9 Lining and Coating

Ductile iron pipe and fittings shall be lined with Type II cement mortar lining. Outside coating shall be manufacturer's standard coal-tar dip coating.

# 4.12.10 Connections with Existing Lines

Where connections are made between new work and existing piping, such connections shall be made using fittings suitable for the conditions encountered. Each connection with an existing pipe shall be made at the time and under conditions which will least interfere with normal operation and as directed by the OWNER. If Solid Sleeves are utilized, only 'long' sleeves are approved unless prior approval is obtained from the OWNER.

# 4.12.11 Bedding

Unless designated otherwise on the Plans, bedding shall be Type II as detailed in the project drawings. Bedding material shall be a granular material that will remain firm and not permit displacement of the pipe either during pipe laying and backfilling or following completion of construction. The material shall consist of crushed gravel meeting the requirement of ASTM C33, Gradation 67 (3/4" to No. 4); Crushed stone or naturally round gravel meeting TxDOT Grade 5 gradation as per Tex-200-F, Part I; or other materials approved by the OWNER (such as Turner Pit 'D' Bedding).

# 4.12.12 Measurement and Payment

Measurement and payment for this item will be based on the lump sum price bid. Payment will include full compensation for excavation, embedment, backfill, furnishing, hauling and laying pipe, fittings (other than valves), testing, disinfection, etc., in accordance with the specifications, Plans and /or instructions of the OWNER.

# 4.14 – Filter Media

### 4.14.0 Scope of Work

This section requires the furnishing of filter media for installation into fifteen (15) filter cells totaling 7713 square feet. The filters shall consist of 12 inches of silica sand media, and 30 inches of anthracite media.

#### **4.14.1 Quality Assurance**

The filter equipment manufacturer shall furnish a Quality Control Manual demonstrating that the filter media to be furnished will comply with the requirements of the contract specifications.

The Quality Control Manual will define the following:

- 1. Qualification of the raw feedstock
- 2. Control procedures at the screening mill
- 3. Independent testing laboratories
- 4. Packaging definition
- 5. Purchase orders
- 6. Storage procedures

#### **4.14.2 Submittal Information**

The technical information will be provided and approved by a licensed engineer regularly employed by the filter manufacturer. The engineer shall have at least 15 years experience in water treatment.

All submittal shall include the following information as a minimum:

- 1. Supplier's Name
- 2. Resume of Engineer Providing Submittal
- 3. Quality Control Manual
- 4. Gradation of Each Media Type
- 5. Date of Sampling/Lot Number
- 6. Samples of Each Media Type (If Required)
- 7. Representative Sample Analysis, (i.e. effective size, uniformity coefficient, specific gravity, acid solubility and MOH hardness for Anthracite only.)
- 8. Material Quantities
- 9. Diagram with Type of Material and Depth of Each
- 10. Estimated Shipping Schedule
- 11. Media Loading Procedure
- 12. All testing shall conform to the requirements of the latest edition of AWWA B100.

#### 4.14.3 Shipments

Media materials will not be shipped until the submittal is approved by the OWNER. Approval of the submittal, including the Quality Control Manual, samples and independent testing, shall constitute acceptance of the media.

The schedule of work shall be submitted to the OWNER for approval prior to commencement of work. The contractor shall be responsible for coordinating the shipment of supplies of

materials and equipment specified herein. The OWNER shall designate a storage space for the filter media and the CONTRACTOR shall maintain material and space in a neat and tidy condition.

# 4.14.4 Filter Media

# 4.14.4.1 Sand

Filter sand shall be composed of hard, durable clean siliceous particles, free of all mica with an average specific gravity of 2.6 ( $\pm$ .05) and shall be in strict accordance with AWWA B100, and have an effective size of 0.45-0.55 mm, and a uniformity coefficient of 1.40 or less, for a finished depth after backwashing and scraping and removal of fines and debris of 12 inches. A 1/2-inch skimming allowance shall be provided.

# 4.14.4.2 Anthracite

Filter anthracite shall be composed of specially selected and graded hard, durable anthracite coal particles. The anthracite shall be composed entirely of deep mined material. A quality control manual shall be included to show the source of the material and the quality of the material produced. The anthracite shall have an average specific gravity of  $1.65 (\pm .05)$  with a hardness (MOH scale) of 2.7 or more and shall be essentially free of iron, clay, shale, extraneous dirt, and excessive dust with moisture less than 4.0 percent as shipped. The anthracite shall be in accordance with AWWA B100, and have an effective size of 0.95-1.0mm, and a uniformity coefficient of 1.40 or less for a finished depth after backwashing and scraping and removal of fines and debris of 30 inches. A skimming allowance of 1-inch shall be provided.

# 4.14.5 Packaging and Shipment

All filter media will be shipped in "semi-bulk" containers having lifting loops and bottom discharge spout, weighing approximately 2,000-4,000 pounds each. Delivery of "bulk" shipments will not be permitted unless the contractor can demonstrate that the materials can be handled and stored without contamination

# 4.14.6 Installation

# 4.14.6.1 Marking and Measuring

Marks shall be placed on the side of the filter designating the top elevation of each layer. Measure depth of each layer of media after it has been backwashed and skimmed as recommended by the filter equipment manufacturer.

# 4.14.6.2 Cleaning

Clean the filter tanks before any media is placed and keep them clean throughout the placing operation.

# 4.14.6.3 Placing

Place the filter sand and filter anthracite in the bed in the order of their respective specific gravities. Place and level the filter sand first. Then backwash the filter bed, and remove the surface fines by scraping as required to the correct elevation. Place the filter anthracite and

backwash the filter bed, and remove the surface fines by scraping as required to the correct elevation.

# 4.15 – Protective Coating Systems

# 4.15.0 General

### 4.15.0.1 Section Includes

Furnish labor, materials, equipment, and incidentals necessary to apply protective coatings to material and equipment as specified herein, including the preparation of surfaces prior to application of coatings.

### 4.15.0.2 Quality Assurance

Steel and Ductile Iron pipe shall be coated in accordance with AWWA C222.

The paint manufacturer shall provide a representative to visit the jobsite at sufficient intervals during surface preparation and painting as may be required for product application quality assurance, and to determine compliance with manufacturer's instruction and these Specifications, and as may be necessary to resolve field problems attributed to, or associated with, the manufacturer's products furnished under the Contract.

Coating System Applicator shall have five years practical experience in application of specified products. Submit a list of recent projects and names of references for those projects. The OWNER may waive the requirement for five years of experience, when at the discretion of the OWNER, the applicator's experience and capabilities meet the intent of the experience requirement. **Coating applicator shall be certified by the coating manufacturer as an approved applicator.** 

Where ANSI/NSF Standard 60 and 61 approval is required, submit ANSI/NSF certification letter for each coating in the system indicating product application limits, dry film thickness, number of coats, specific product tested, colors certified, and approved additives.

Adequate illumination shall be provided while work is in progress. Whenever required by the inspector, the CONTRACTOR shall provide additional illumination and necessary supports to cover all areas to be inspected. The level of illumination for inspection purposes shall be determined by the inspector.

Ventilation shall be used to control potential dust and hazardous conditions within confined areas. Ventilation flow rates shall be in accordance with OSHA regulations and as required to reduce air contamination to nonhazardous conditions.

# 4.15.0.3 Inspection

Inspect and provide substrate surfaces prepared in accordance with these specifications and the printed directions and recommendations of paint manufacturer whose product is to be applied. Provide OWNER minimum 3 days advance notice prior to start of surface preparation work or coating application work.

Perform Work only in the presence of OWNER, unless OWNER grants prior approval to perform such work in Owner's absence. Approval to perform work in the Owner's absence is limited to the current day unless specifically noted to extend beyond the completion of the workday. Inspection by the OWNER, or the waiver of inspection of any particular portion of the Work, shall not be construed to relieve the CONTRACTOR of responsibility to perform the Work in accordance with these specifications.

# 4.15.0.4 Testing

CONTRACTOR shall provide appropriate testing device(s) to verify coating thickness specified in mils and to check for holidays and discontinuities.

Adhesion tests shall be performed in accordance with AWWA C222

Holiday tests on polyurethane coatings or linings will be conducted on the completed coating or lining after cure or 24-hours, whichever is less, using a high voltage spark test in accordance with NACE Standard RP-0274 and these specifications. Coating thickness used for holiday testing shall be the minimum specified coating thickness.

Coatings shall be tested for dry film thickness using a properly calibrated magnetic pull off or eddy current equipment. Coating thickness measurements shall be conducted as necessary and without limitation. Testing conformance to the requirements of SSPC PA-2 is specifically excluded from this specification.

Testing devices shall be as manufactured by Nordson Crop or DeFelsko Crop.

# 4.15.1 Materials

# **4.15.1.1 Paint Materials**

Products shall meet federal, state, and local requirements limiting the emission of volatile organic compounds. Paint material for steel, ductile and cast iron pipe shall be self-priming, plural component, 100 percent solids, non-extended polyurethane, suitable for burial or immersion.

# 4.15.1.2 Delivery, Storage and Handling

Deliver paint to the project site in unopened containers that plainly show, at the time of use, the designated name, manufacture date, color, and name of manufacturer. Store paints in a suitable protected area that is heated or cooled as required to maintain temperatures within the range recommended by the paint manufacturer. Material shall be stored and handled per manufacturer's written directions.

# 4.15.1.3 Manufacturers

Coating material shall be one of the following products, subject to review and acceptance of submitted product performance reports:

- a) Carboline 777, Carboline, St. Louis, MO
- b) Protec II, Futura Coatings, Hazelwood, Missouri
- c) Chemthane 2265, Chemline, St. Louis MO

Other manufacturers for consideration of the OWNER shall be submitted a minimum of 7 days prior to bid opening.

# 4.15.1.4 Colors

Paint colors provided shall consist of up to five (5) colors used to designate commonly encountered piping components within a water treatment system Colors may include white, light brown, dark brown, tan, light blue, dark blue, purple, yellow, green and others. Final paint colors shall be selected by the OWNER from color palette from approved coating manufacturer submitted by CONTRACTOR.

# 4.15.2 Surface Preparation

Surface preparation and costing application shall be in conformance with the coating manufacturer's written product data sheets and written recommendations of the manufacturer's technical representative. Where conflicts occur with the information presented, the more stringent of the two shall apply unless approved by the OWNER.

# 4.15.2.1 Existing Coated Surfaces

Shop primed or coated surfaces shall be reviewed with the Engineer to determine the extent of existing coating damage and suitability of the finish coats to adhere to the shop applied coats.

If a cured epoxy, polyurethane, or plural-component material is to be top coated, contact the coating manufacturer concerned for additional surface preparation requirements. At a minimum, existing coated surfaces shall be sanded to remove all gloss and to roughen the existing surface for adhesion of subsequent coats. Surface preparation recommendations of the manufacturer shall be subject to approval of the OWNER.

All existing coated surfaces, where demolition of equipment was specified or required, shall be surface prepared, touch-up coating repairs completed, and a cosmetic overcoat applied using the specified coating system on all existing coated surfaces associated with the demolition work, unless otherwise specified.

Apply sealer/primer where recommended by coating manufacturer for coating compatibility.

# 4.15.2.2 Steel Surface Preparation

Surface preparation of steel pipe shall be in accordance with SSPC surface preparation standards utilizing the degree of cleanliness specified for the coating system to be applied or as specified herein, whichever is more stringent. Grit and/or shot abrasive mixture and gradation shall be as required to achieve the degree of cleanliness and coating adhesion specified. Pipe cleaned by abrasive blasting with recyclable steel grit and/or shot or other abrasive shall be cleaned of debris and spent abrasive in an air wash separator.

Polyurethane coated steel shall have a sharp angular surface profile of the minimum depth specified. After abrasive blasting surfaces and before coating application, the metal surface shall be cleaned of residual dust to a minimum of Grade 2 per ISO Standard 8502-3, Test for the Assessment of Surface Cleanliness.

Work shall be performed in a manner that does not permit the cleaned metal surface to rust back or flash rust. Rust back or flash rust shall be fully removed with the steel surface cleanliness equal to the metal surface cleanliness prior to rust back or flash rusting. Determination of the equivalent surface cleanliness shall be at the OWNER'S sole discretion.

# 4.15.2.3 Ductile Iron Surface Preparation

Surface preparation cleanliness shall be similar to the equivalent SSPC surface preparation grade as specified with consideration that color of blasted ductile iron will not match that of abrasively blasted steel. Properly cleaned ductile or cast iron will be a near-gray color.

Use SSPC SP grades as a surface preparation guide only for percentage cleanliness required and surface contaminants removed. Abrasive cleaning shall remove the same percentage of all surface contaminants (including tightly adhered annealing scale) as specified in the SSPC standard. Avoid over blasting, high nozzle velocities, and excessive blast times. Abrasive blasting of cast or ductile iron shall be performed in a manner to avoid lifting or exfoliating of the metal surface. Pipe manufactured using the deLavaud Process (dual spray) are highly susceptible to exfoliation of the metal surface. Any surface exfoliation shall be removed by grinding followed by reblasting. The entire surface area shall be abrasive blasted. No tight rust stains shall be allowed.

Applicator and OWNER will agree on an acceptable level of blast at the beginning of the project that will become the standard from which all other blast work will be compared

# 4.15.3 Application

# 4.15.3.1 Dehumidification

Where weather conditions or project requirements dictate, CONTRACTOR shall provide and operate dehumidification and appropriate ventilation equipment to maintain environmental conditions suitable for abrasive blasting and coating application as specified herein and in accordance with the manufacturer's published instructions and product data sheets. CONTRACTOR shall provide and operate desiccant dehumidification equipment to maintain environmental conditions for 24 hours a day during abrasive blasting and coating application and coating application and coating cure. Liquid, granular, or loose lithium chloride drying systems will not be acceptable.

CONTRACTOR shall provide dehumidification equipment sized to maintain dew point temperature 17 degrees or more below surface temperature of metal surfaces to be cleaned and coated. System shall provide air flows as required to maintain positive pressure and ventilation within the environmentally controlled areas, Work activities within environmentally controlled areas shall meet all of the following requirements:

- 1. Two air exchanges per hour, minimum,
- 2. Personnel exposures limits (PEL) at 50 percent of OSHA PEL limits for all chemicals used in the performance of the work, and
- 3. Lower explosive limits (LEL) to less than 50 percent of the most volatile solvent used in the performance of the work.

Dehumidification and ventilation equipment shall also provide ventilation at a minimum of 0.75 air exchanges per hour within all accessible work areas for worker protection or as required for maintaining PEL and LEL explosive limits as defined herein, whichever is more stringent. Dehumidification and ventilation equipment type, size, air flow, and power requirements shall be designed by a qualified company knowledgeable in dehumidification equipment, and its operation based on project requirements and anticipated seasonal weather conditions for the project schedule. Design to include evaluation of existing conditions, humidity, and temperature, proper air exchange requirements, ventilation requirements, ducting

requirements for adequate air flow, and any other issues necessary to achieve the specified performance and environmental conditions throughout the duration of the project.

CONTRACTOR to submit written recommendations from dehumidification subcontractor for bulkhead locations, bulkhead venting, duct work for each bulkhead section, any secondary ventilation requirements for coating cure, dust collection equipment CFM requirements, and drying requirements for blast hose compressed air necessary to maintain environmental control as specified herein. At a minimum, bulkheads shall be provided to separate surface preparation work zones, coating application zones, and coating cure zones.

Dehumidification subcontractor shall either operate the equipment or provide training to CONTRACTOR on the proper operation and setup of dehumidification equipment. Dehumidification subcontractor shall provide a technical representative on site for a minimum of two 8 hour days to insure proper operation of the equipment, achievement of desired environmental control, and to insure CONTRACTOR can properly setup, operate, monitor, and maintain the equipment. Dehumidification and ventilation equipment shall be operated in a manner that prevents all condensation or icing throughout surface preparation and coating application and cure.

Reblasting of flash rusted metal surfaces or removal of damaged coatings, as a result of equipment malfunction, shutdown, or other events that result in the loss of environmental control, will be at the sole expense of the CONTRACTOR. Cleaned metal surfaces subject to flash rusting shall be cleaned to the same cleanliness as prior to the flash rust formation and shall be approved by the OWNER.

CONTRACTOR shall monitor ambient temperature, humidity, dew point temperature, and pipe surface temperature both outdoors and within the work area at the start, midpoint, and end of each work shift, minimum, but not greater than 5 hours between measurements.

Daily environmental condition monitoring and maintenance of the equipment shall be documented in writing and posted near the equipment for review by the OWNER.

# 4.15.3.2 Film Thickness

Film thickness for polyurethane coating systems shall be 35 mils total dry film thickness, minimum, or as specified by coating manufacturer or required to meet holiday and coating defects requirements.

Coverage is listed as either total minimum dry film thickness in mils (MDFT) or the spreading rate in square feet per gallon (SFPG). Per coat determinations are listed as MDFTPC or SFPGPC. Applied coating system film thickness per coat shall be applied at the specified coating thickness or the manufacturer's recommended minimum thickness, whichever is greater. Where the manufacturer has not specified a minimum coating thickness on the product data sheets, the minimum recommended coating application thickness shall apply. Maximum film build per coat shall not exceed the coating manufacturer's recommendations.

# 4.15.3.3 Number of Coats

Apply specified number of coats, minimum, irrespective of coating thickness. Additional coats may be required to obtain the minimum required paint thickness, depending on the method of application, differences in manufacturers' products, and atmospheric conditions.

# 4.15.4 Repair of Coating and Linings

# 4.15.4.1 General

All areas where holidays are detected or coating is visually damaged, such as blisters, tears, rips, bubbles, wrinkles, cuts, or other defects shall be repaired. Areas where no holidays are detected, but are visually damaged shall also be repaired. Maximum defects allowable shall be as specified herein for the coating system.

# 4.15.4.2 Polyurethane Coatings or Lining Repairs

Complete coating or lining repairs in accordance with the coating manufacturers written instructions and these specifications, whichever is stricter.

Defect Size:

a. Minor repairs - repairs that are less than 6-inches in the greatest dimension.

b. Major repairs - repairs that exceed 6-inches in the greatest dimension.

#### 4.15.4.2.A Maximum Quantity of Defects Allowed:

Coating or lining repairs on any joint of pipe shall not exceed 1.5 per 100 square feet of surface area.

1) Two or more minor repairs within a 6-inches diameter circle will be considered a single repair.

2) Repairs for adhesion testing will not be included in the total number of repairs.

Major repairs shall not exceed three per pipe joint and the combined area shall not be greater than 40 percent of the pipe. Pipes exceeding the maximum number or size of coating defects shall be stripped of coating, reblasted, and recoated. Pipe arriving in the field with defects or repairs exceeding the maximum number or size of coating defects will be returned to the shop for recoating at the CONTRACTOR'S expense.

#### 4.15.4.2.B Minor Repairs:

1) Surface Preparation:

(a) Clean and feather the defect by power tool sanding with 80 grit or coarser sandpaper to roughen the existing coat and feather the edges of the defect for a minimum of 2-inches around the defect.

2) Shop repair Materials:

(a) Single use polyurethane coating kits using single use packaging that controls mix ratio.

(b) Tapecoat Protal 7125 fast cure epoxy

(c) Coating Manufacturer's polyurethane coating repair products subject to Engineer approval.

3) Field Repair Materials:

(a) Heat applied coating materials; CRP Patch, Canusa; PERP Patch, Tyco Adhesives, or approved equal.

(b) Tapecoat Protal 7125 fast cure epoxy

(c) Single use polyurethane coating kits using single use packaging that controls mix ratio.

(d) Coating Manufacturer's polyurethane coating repair products subject to Engineer approval.

4) Clean and feather the defect by power tool sanding with 80 grit or coarser sandpaper to roughen the existing coating and feather defect edges minimum of 2-inches.

5) Apply a single coat of the specified patch coating material at the specified coating thickness.

6) Repair coating adhesion shall be 50 percent of the specified coating adhesion.

#### 4.15.4.2.C Major Repairs:

1) Surface Preparation:

(a) The metal surface and surrounding coating shall be abrasively blasted in accordance with SSPC-SP10, near white metal, or to equal in cleanliness and profile as the original surface preparation. Existing coating shall be feathered and roughened to the equivalent of 40 grit sandpaper.

#### 2) Shop Repair Materials:

(a) Same material as the pipeline coating or lining and shall be applied by using plural component spray equipment.

#### 3) Field Repair Materials:

- (a) Same material as the pipeline coating or lining and shall be applied
- by using plural component spray equipment.
- (b) Heat shrink sleeves as specified for pipeline joints.

One coat of the specified original coating material shall be applied over the repaired surface at the specified thickness. Repair adhesion shall be equal to the specified coating adhesion.

#### 4.15.5 Measurement and Payment

Measurement and payment for this item will be based on the lump sum price bid. Payment will include full compensation for material, surface preparation, application, testing, etc. in accordance with the specifications, Plans and /or instructions of the OWNER.

# 4.16 - Cast in Place Concrete

### 4.16.0 General

#### 4.16.0.1 Scope

This section covers all cast-in-place concrete, including reinforcing steel, forms, finishing, curing, and other appurtenant work. All cast-in-place concrete shall be accurately formed and property placed and finished as shown on the Plans and specified herein.

The CONTRACTOR shall inform the OWNER at least twenty-four (24) hours in advance of the times and places at which he intends to place concrete.

#### **4.16.1 Data and Drawings**

All submittals of data and drawings shall be in accordance with the submittals section unless otherwise noted herein.

#### 4.16.2 Materials

- a) Cement ASTM C150, Type I, II, or III
- b) **Fine Aggregate** Clean natural sand, ASTM C33.Artificial or manufactured sand will not be acceptable.
- c) **Coarse Aggregate** Crushed rock, washed gravel, or other inert granular material conforming to ASTM C33, except that clay and shale particles shall not exceed one percent.
- d) Water Clean and free from deleterious substances.

#### e) Admixtures:

- 1. **Retarder** ASTM C494, Type D; Grace "Daratard-HC", Master Builders "MB-HC", Protex "Protard", or Sika Chemical "Plastiment".
- 2. **Plasticizer** ASTM C494, Type A; Grace "WRDA-HC", or Master Builders "MBHC-N".
- 3. **Super Plasticizer** ASTM C494, Type F, American Admixtures "Melment 10A", Gifford-Hill "PSI-Super", Sida "Sikament", or W.R. Grace "WRDA-19".
- 4. **Air-Entraining** ASTM C260; Grace "Darex AEA", Master Builders "MB-AE10", Protex "AES", or Sika Chemical "AER".
- f) **Reinforcing Steel** Bars, Except ASTM A615 (and Supplement S1) Weldable Grade 60, deformed. Bars, Weldable ASTM A706 or A615 (and Supplement S1) Grade 60, deformed, with maximum carbon equivalent of 0.55.
- g) Welded Wire Fabric ASTM A185 or A497.

- h) Bar Supports CRSI Class 1, plastic protected, or Class 2, stainless steel protected.
- i) **Forms** Prefabricated Simplex "Industrial Steel Frame Forms", Symons "Steel Ply", or Universal "Uni-form".
- j) **Plywood** Product Standard PS1, water-proof, resin-bonded, exterior type Douglas fir; face adjacent to concrete Grade B or better.
- k) **Fiberboard** Fed Spec LLL-B-810, Type II tempered, waterproof, creenback, concrete form hardboard.
- 1) **Lumber** Straight, uniform width and thickness, and free from knots, offsets, holes, dents, and other surface defects.
- m) Chamfer Strips Clear white pine, surface against concrete planed.
- n) **Form Coating** Non-Crete "Form Coating", L&M "Debond", Protex "Pro-Cote, or Richmond "Rich Cote".
- o) Wedge Inserts Malleable iron, with galvanized askew-head bolts, nuts, and washers; Hohmann and Barnard "HW", Richmond "Peerless", or Weston "WC50".
- p) **Polyethylene Film** Product Standard PS17; 6 mil. Membrane Curing Fed Spec TT-C-800, Type I,
- q) **Compound and Floor** Class 1; min eighteen percent (18%) solids.
- r) **Sealer** Non-yellowing; unit moisture loss 0.039 gm/cm<sup>2</sup> max; ProSoCo "Dure and Seal", Protex "Acrychlor", or Sonneborm Kure-N-Seal".

# 4.16.3 Preliminary Review

All tests and reports required for preliminary review shall be made by an independent testing laboratory at the expense of the CONTRACTOR. Reports covering the source and quality of concrete materials and the concrete proportions proposed for the work shall be submitted to the OWNER for review before concrete work is started. Review of these reports will be for general acceptability only and continued compliance with all contract provisions will be required.

# 4.16.4 Aggregates

Reports on aggregates shall include the following information:

- a) Fine Aggregate.
  - Source and type
  - Gradation.
  - Deleterious Substances.
- b) Coarse Aggregate.
  - Source and type.
  - Gradation and abrasion loss.

- Deleterious substances.
- Results of sodium or magnesium sulfate soundness test.

# 4.16.5 Mix Design

A tentative concrete mix shall be designed and tested for each size and gradation of aggregates and for each consistency intended for use in the work. Design quantities and test results of each mix shall be submitted for review. Mixes shall be adjusted in the field as necessary to meet the requirements of these specifications. The report for each tentative concrete mix submitted shall contain the following information:

- a) Slump on which design is based.
- b) Total gallons of water per cubic yard.
- c) Brand, type, composition, and quantity of cement.
- d) Specific gravity and gradation of each aggregate.
- e) Ratio of fine to total aggregates.
- f) Weight (surface dry) of each aggregate per cubic yard.
- g) Brand, type, ASTM designation, active chemical ingredients, and quantity of each admixture.
- h) Air content.
- i) Compressive strength based on seven (7) day and twenty-eight (28) day compression tests.
- j) Time of initial set.

# 4.16.6 Testing

Aggregates shall be sampled and tested in accordance with ASTM C33. In addition, the bulk specific gravity of each aggregate shall be determined in accordance with ASTM C127 and ASTM C128.

Two sets of compression test cylinders, three cylinders per set, shall be made from each proposed concrete mix. One set of three cylinders shall be tested at an age of seven (7) days and the other set shall be tested at an age of twenty-eight (28) days. Concrete test specimens shall be made, cured, and stored in conformity with ASTM C192 and tested in conformity with ASTM C39.

Slump shall be determined in accordance with ASTM C143 and total air content shall be determined in conformity with ASTM C231. Initial set tests shall be made at ambient temperatures of seventy degrees (70°F) and ninety degrees (90°F) to determine compliance with the initial set time specified hereinafter. The test at seventy degrees (70°F) shall be made

using concrete containing the specified plasticizing and air-entraining admixtures. The test at ninety (90°F) shall be made using concrete containing the specified retarding and air-entraining admixtures. Initial set shall be determined in accordance with ASTM C403.

# 4.16.7 Limiting Requirements

Unless otherwise specified, each concrete mix shall be designed and concrete shall be controlled within the following limits.

# 4.16.7.1 Cement Content

The quantity of Portland cement, expressed in pounds per cubic yard, shall be as shown in the following table. These minimum cement quantities shall apply only to concrete containing a specified water reducing admixture. If, for any reason, the water reducing admixture is omitted, the cement shall be increased ten percent (10%).

Concrete Slump	Course Aggregate Size (lbs. Cement per Cubic Yd.)		
(in.)	No. 4 to 2"	3/4''	1''
2	573	545	517
3	593	56	536
4	611	583	555
5	630	602	573
6	649	620	593

# 4.16.7.2 Total Water Content

Total water content of concrete shall not exceed six (6) gallons of water per hundred pounds of cement in the mix.

# 4.16.7.3 Slump

Concrete slump shall be kept as low as possible consistent with proper handling and thorough compaction. Unless otherwise authorized by the OWNER, slump shall not exceed four inches (4").

When Super plasticizer is used, slump, for concrete shall not exceed three inches (3") prior to adding any super plasticizer. Slump for concrete after super plasticizer has been added shall be six inches (6") plus or minus one inch (1").

# **4.16.7.4 Ratio of Fine to Total Aggregates**

The ratio of fine to total aggregates based on solid volumes (not weights) shall be:

Coarse Aggregate Size (in.)	Minimum Ratio	Maximum Ratio
2	0.40	0.55
3/4	0.35	0.50
1	0.30	0.46

# 4.16.7.5 Initial Set

The initial set as determined by ASTM C403 and after the water and cement are added to the aggregates. The quantity of retarding or accelerating admixture shall be adjusted to compensate for variations in temperature and job conditions.

# 4.16.7.6 Total Air Content

The total volumetric air content of concrete after placement shall be five to seven percent (5%-7%). Air may be omitted from interior slabs which are to be trowel finished.

# 4.16.7.7 Admixtures

Admixtures, other than air-entraining and water reducing admixtures will not be permitted unless approved by the OWNER. The admixture content, batching method, and time of introduction to the mix shall be in accordance with the manufacturer's recommendation for compliance with these specifications. A water reducing admixture shall be included in all concrete. No calcium chloride or admixtures containing chloride from other than impurities from admixture ingredients will be acceptable. At the option of the CONTRACTOR, a super plasticizer may be used in addition to any water reducing admixture in all concrete for the prestressed concrete reservoir. Super plasticizer shall be as specified, as recommended by the manufacturer, and acceptable to the OWNER. Easy verification of each admixture dose when dispensed at the site will be required. Super plasticizer shall be accurately proportioned for each load into a separate dispensing container prior to any discharge into the truck. When truck-mounted dispensers are used, no flushing or cleaning of the system with water will be allowed until after the entire load of concrete has been discharged. Redosing of concrete with super plasticizer may be done only once when acceptable to the OWNER. Redosing procedures shall be as recommended by the manufacturer and acceptable to the OWNER.

# 4.16.7.8 Chloride Content

Maximum water soluble chloride in the concrete shall be 0.06 percent by weight.

# 4.16.7.9 Storage of Materials

Cement shall be stored in suitable moisture-proof enclosures. Cement which has become caked or lumpy shall not be used.

Aggregates shall be stored so that segregation and the inclusion of foreign materials is prevented. The bottom six inches (6") of aggregate piles in contact with the ground shall not be used.

Reinforcing steel shall be carefully handled and shall be stored on supports which will keep the steel from contact with the ground.

# 4.16.8 Forms

Forms shall be designed to produce hardened concrete having the shape, lines, and dimensions shown on the Plans. Forms shall conform to ACI 347 and the following additional requirements.

Forms for surfaces which will be exposed to view when construction is completed shall be prefabricated plywood panel forms, job-built plywood forms, or forms that are lined with

plywood or fiberboard. Forms for exposed surfaces shall be laid out in a regular and uniform pattern with the long dimension of panels vertical and all joints aligned. The forms shall produce finished surfaces that are free from offsets, ridges, waves, and convex areas, within the tolerances specified herein.

Plywood or lined forms will not be required for surfaces which are normally submerged or not ordinarily exposed to view, such as the insides of manholes, basins, and reservoirs. Other types of forms, such as steel or unlined wooden forms, may be used for surfaces which are not restricted to plywood or lined forms and may be used as backing for form linings. Concrete forms are required above all extended footings. Flat segmented forms not more than 24-inches wide may be used for forming curved surfaces twenty-five feet (25') in diameter or larger. Where concrete is placed against gravel or crushed rock which does not contain at least twenty-five percent (25%) material passing a No. 4 sieve, such surfaces shall be covered with polyethylene film to protect the concrete from loss of water. Joints in the film shall be lapped at least 6 inches. Where concrete is placed against rock, all loose pieces of rock shall be removed and the exposed surface cleaned with a high pressure hose.

# 4.16.8.1 Design

Forms shall be substantial and sufficiently tight to prevent leakage of mortar. Forms shall be braced or tied to maintain the desired position, shape, and alignment during and after concrete placement. Walers, studs, internal ties, and other form supports shall be sized and spaced so that proper working stresses are not exceeded.

Beams and slabs supported by concrete columns shall be formed so the column forms may be removed without disturbing the supports for the beams or slabs. Wherever the top of a wall will be exposed to weathering, the forms on at least one side shall not extend above the top of the wall and shall be brought to true line and grade. At other locations, forms shall be brought to a true line and grade, or a wooden guide strip shall be provided at the proper location on the forms so that the top surface can be finished with a screed or template for concrete which is to be finished to a specified elevation, slope, or contour. At horizontal construction joints in walls, the forms on one side shall not extend more than two feet (2') above the joint.

Temporary openings shall be provided at the bottom of column and wall forms and at other points where necessary to facilitate cleaning and inspection.

# 4.16.8.2 Form Ties

Form ties shall be of the removable end, permanently embedded body type and shall have sufficient strength and rigidity to support and maintain the form in proper position and alignment without the use of auxiliary spreaders. Cones shall be provided on the outer ends of each tie and the permanently embedded portion shall be at least one-inch back from the concrete face. Form ties for water bearing walls shall be provided with water-seal washers located on the permanently embedded portions of the ties at the approximate center of the wall. Permanently embedded portions of form ties which are not provided with threaded ends shall be constructed so that the removable ends are readily broken off without damage to the concrete. The type of form ties used shall be acceptable to the OWNER. Form ties in exposed surfaces shall be uniformly spaced and aligned in horizontal and vertical rows.

# 4.16.8.3 Edges and Corners

Chamfer strips shall be placed in forms to bevel all salient edges and corners, except the top edges of walls and slabs which are to be tooled and edges which are to be buried. Equipment bases shall have formed beveled salient edges for all vertical and horizontal corners unless specifically shown otherwise on the Plans. Unless otherwise noted, bevels shall be 3/4- inch wide.

# 4.16.8.4 Form Removal

Forms shall not be removed or disturbed until the Concrete has attained sufficient strength to safely support all dead and live loads. Shoring beneath beams or slabs shall be left in place and reinforced as necessary to carry any construction equipment or materials placed thereon. Care shall be taken in form removal to avoid surface gouging, corner or edge breakage, and other damage to the concrete.

# 4.16.8.5 Reinforcements

Reinforcements shall be accurately formed and shall be free from loose rust, scale, and contaminants which reduce bond. Unless otherwise shown on the Plans or specified herein, the details of fabrication shall conform to ACI 315 and 318.

# 4.16.8.6 Shop Drawings and Bar Lists

Bar lists and drawings for the fabrication and placing of reinforcements shall be submitted for review to the OWNER.

# 4.16.8.7 Placements

Reinforcements shall be accurately positioned on supports, spacers, hangers, or other reinforcements and shall be secured in place with wire ties or suitable clips.

With the exception of contact splices, the clear distance between parallel bars shall be not less than two inches (2"). Where reinforcements in beams are placed in two (2) or more layers, the bars in the upper layer shall be placed directly above the bars in the lower layer.

Reinforcements shall not be installed for beams or slabs which are supported by concrete columns until after the concrete for the column has been placed.

# 4.16.8.8 Splices

Splices shall conform to the details shown on the Plans. Splices at locations other than those shown on the Plans shall be acceptable to the OWNER. Except where indicated on the Plans, welding or tack welding of reinforcement is prohibited. Where welding is indicated on the Plans, weldable reinforcing steel having a carbon equivalent of not more than 0.55 shall be provided, and preheating and welding shall conform to AWS D1.4. Reinforcements upon which improper or unauthorized welding has been done shall be removed and replaced.

# 4.16.9 Embedments

Anchor bolts, castings, steel shapes, conduit, sleeves, masonry anchorage, and other materials that are to be embedded in the concrete shall be accurately positioned in the forms and securely anchored. Conduits shall be installed between the reinforcing steel in walls or slabs which have reinforcement in both faces. In slabs which have only a single layer of reinforcing steel,

conduits shall be placed under the reinforcement. Unless installed in pipe sleeves, anchor bolts shall have sufficient threads to permit a nut to be installed on the concrete side of the form or template. A second nut shall be installed on the other side of the form or template and the two nuts shall be adjusted so that the bolt will be held rigidly in proper position.

Embedments shall be clean when installed. After concrete placement, surfaces not in contact with concrete shall be cleaned of concrete spatter and other foreign substances.

# 4.16.10 Batching and Mixing

Concrete shall be furnished by an acceptable read-mixed concrete supplier and shall conform to ASTM C94.

### 4.16.11 Consistency

The consistency of concrete shall be suitable for the placement conditions. Aggregates shall float uniformly throughout the mass and the concrete shall flow sluggishly when vibrated or spaded. The slump shall be kept uniform.

# 4.16.12 Delivery Tickets

A delivery ticket shall be prepared for each load of ready-mixed concrete. A copy of each ticket shall be handed to the OWNER by the truck operator at the time of delivery. Tickets shall show the mix identification, quantity delivered, the amount of each material in the batch, the outdoor temperature in the shade, the time at which the cement was added, and the numerical sequence of the delivery.

### 4.16.13 Placement

The limits of each concrete pour shall be predetermined by the CONTRACTOR and shall be acceptable to the OWNER. All concrete within such limits shall be placed in one continuous operation. Before concrete is placed, forms, reinforcements, water stops, anchor bolts, and embedments shall be rigidly secured in proper position; all dirt, mud, water, and debris shall be removed from the space to be occupied by concrete; all surfaces incrusted with dried concrete from previous placement operations shall be cleaned; and the entire installation shall be acceptable to the OWNER.

# 4.16.14 Bonding to Hardened Concrete

The surface of hardened concrete upon which fresh concrete is to be placed shall be rough, clean, sound, and damp. The hardened surface shall be cleaned of all laitance, foreign substances (including curing compound), washed with clean water, and wetted thoroughly preceding placement of fresh concrete. Coarse aggregate shall be omitted from the concrete placed immediately adjacent to hardened concrete in wall or column forms. The mortar puddle shall cover the hardened concrete to a depth of one inch (1"). Standard concrete mix, as specified, shall then be placed over the mortar.

# 4.16.15 Conveying Concrete

Concrete shall be conveyed to the point of final deposit by methods which will prevent separation or loss of ingredients. Concrete shall be placed in final position without being moved laterally in the forms more than five feet (5').

# 4.16.16 Placing Concrete

Concrete shall be placed in approximately horizontal layers of proper depth for effective compaction; however, the depth of a layer shall not exceed twenty-four inches (24"). Each layer of concrete shall be plastic when covered with the following layer and the forms shall be filled at a rate of vertical rise of not less than two feet (2') per hour. Vertical construction joints shall be provided as necessary to comply with these requirements.

Concrete shall be placed and compacted in wall or column forms before any reinforcing steel is placed in the system to be supported by such walls or columns. The portion of any wall or column placed monolithically with a floor or roof slab shall not exceed six feet (6') of vertical height. Concrete in walls or columns shall settle at least two (2) hours before concrete is placed in the structural systems to be supported by such walls or columns. Concrete shall be thoroughly settled when top finished. All laitance, debris, and surplus water shall be removed from concrete surfaces at tops of forms by screeding, scraping, or other effective means. Wherever the top of a wall will be exposed to weathering, the forms shall be overfilled and after the concrete has settled, the excess shall be screeded off.

### 4.16.17 Compaction

During and immediately after placement, concrete shall be thoroughly compacted and worked around all reinforcements and embedments and into the corners of the forms. Mechanical vibrators shall be used which will maintain at least 9,000 cycles per minute when immersed in the concrete. Number and type of vibrators shall be acceptable to the OWNER. Jitterbugs will not be acceptable.

# 4.16.18 Cold Weather Concreting

Except as modified herein, cold weather concreting shall comply with ACI 306. The temperature of concrete as the time of mixing shall be not less than that shown in the following table for corresponding outdoor temperature (in shade) at the time of placement:

<b>Outdoor Temperature</b>	Concrete Temperature
Below 30° F	70° F
Between 30° and 45° F	60° F
Above 45° F	45° F

Do not place concrete in contact with any material coated with frost or having a temperature of thirty-two degrees (32° F) or lower. Do not place concrete when the ambient temperature in the shade is below forty degrees (40° F) and falling unless approved. Concrete may be placed when the ambient temperature in the shade is thirty-five (35° F) and rising or above forty degrees (40° F). When placed, heated concrete shall not be warmer than eighty degrees (80°F). Maintain temperature of all other concrete, including the bottom slab (footings) of culverts, placed on or in the ground above thirty-two degrees (32° F) for seventy-two (72) hours from the time of placement. Concrete and adjacent form surfaces shall be kept continuously moist. Sudden cooling of concrete shall not be permitted.

# 4.16.19 Hot Weather Concreting

Except as modified herein, hot weather concreting shall comply with ACI 305. At air temperatures of ninety degrees (90°F) or above, concrete shall be kept as cool as possible during placement and curing. The temperature of the concrete when placed in the work shall not exceed ninety degrees (90°F). Plastic shrinkage cracking, due to rapid evaporation of moisture, shall be prevented. Concrete shall not be placed when the evaporation rate (actual or anticipated) equals or exceeds 0.2 pound per square foot per hour, as determined by Figure 2.1.5 in ACI 305.

# 4.16.20 Testing

Field control tests, including aggregate gradation tests, slump tests, air content tests, and making compression test cylinders, shall be performed by testing laboratory personnel. The testing laboratory shall provide all facilities and the services of one or more employees as necessary to assist with the field control testing activities. As stipulated in the quality control section, tests required during the progress of the work shall be made at the expense of the CONTRACTOR. The frequency hereinafter specified for each field control test is approximate. A greater or lesser number of tests may be made, as required by the OWNER.

Field testing prior to any addition of super plasticizer shall be as required by the OWNER to determine compliance with the specifications and shall be conducted as specified. Field testing after the addition of super plasticizer shall be conducted as specified and as required to determine that the concrete is in compliance with the specifications. Air tests shall be conducted whenever field tests are conducted.

# 4.16.20.1 Aggregate Gradation

Each 100 tons of fine aggregate and each 200 tons of coarse aggregate shall be sampled and tested in accordance with ASTM D75 and C136.

# 4.16.20.2 Slump

A slump test shall be made for each fifty cubic yards (50 yd<sup>3</sup>) of concrete. Slump shall be determined in accordance with ASTM C143.

# 4.16.20.3 Air Content

An air content test shall be made from one of the first three (3) batches mixed each day, and from each batch of concrete from which concrete compression test cylinders are made. Air content shall be determined in accordance with ASTM C231.

# 4.16.20.4 Compression Tests

A minimum of one set of four (4) concrete compression test cylinders shall be made for each forty cubic yards (40 yd<sup>3</sup>) of concrete that is placed. Two (2) additional sets shall be made from each additional 100 cubic yards, or major fraction thereof, placed in any one day. Two cylinders of each set shall be tested at an age of seven (7) days and the other cylinders shall be tested at an age of twenty-eight (28) days. Compression tests will be evaluated in accordance with ACI 214 and 318.

Tests cylinders shall be made, cured, stored, and delivered to the laboratory in accordance with ASTM C31 and tested in accordance with ASTM C39. Each set of compression test cylinders shall be marked or tagged with the date and time of day the cylinders were made, the location in the work where the concrete represented by the cylinders was placed, the delivery truck or batch number, the air content, and the slump.

# 4.16.20.5 Test Reports

Test reports shall be prepared in three (3) copies and shall be distributed by the testing laboratory directly to the OWNER and CONTRACTOR in accordance with the quality control section.

# **4.16.21** Construction Joints

Construction joints shall be made at locations indicated on the Plans or specified. Construction joints shall not be made at other locations without the concurrence of the OWNER.

### 4.16.22 Watertight Joints

Construction joints in the following locations shall be watertight and shall be provided with continuous water stops:

- a) Walls in contact with liquid.
- b) Other locations where specifically shown on the Plans.

Water stops shall be of the size and thickness indicated on the Plans and shall be clean and free from coatings that would weaken the bond with concrete. Each water stop shall be continuous throughout the length of the construction joint in which it is installed. Junctions between adjacent sections shall be lapped six inches (6") and securely bolted or welded together. All water stops shall be maintained in proper position until the surrounding concrete has been deposited and compacted. Water stops shall be constructed of material acceptable to the OWNER.

# 4.16.23 Finishing Unformed Surfaces

Buried and permanently submerged concrete blocking and encasement will require no finishing except that necessary to obtain the required surface elevations or contours. The unformed surfaces of all other concrete shall be screeded and given an initial float finish followed by additional floating, and troweling where required.

# 4.16.24 Screeding

Screeding shall provide a concrete surface conforming to the proper elevation and contour with all aggregates completely embedded in mortar. All screeded surfaces shall be free of surface irregularities within a height or depth of 1/4-inch as measured from a ten foot (10') straightedge.

# 4.16.25 Floating

Screeded surfaces shall be given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate which is disturbed by the float or which causes a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance with no unnecessary working of the surface. Initial floating shall be followed by a second floating at the time of initial set. The second floating shall produce a finish of uniform texture and color. Unless additional finishing is specifically required, the completed finish for unformed surfaces shall be the float finish produced by the second floating. Floating shall be performed with hand floats or suitable mechanical compactor-floats.

### 4.16.26 Broom Finish

Surfaces of exterior slabs shall be given a light broom finish providing a nonslip surface. Brooming shall be done after the second floating and at right angles to the normal traffic direction.

### 4.16.27 Edging

Unless specified to be beveled, exposed edges of floated surfaces shall be edged with a tool having 1/4-inch corner radius.

### 4.16.28 Curing

Concrete shall be protected from loss of moisture for at least seven (7) days after placement; however, when concrete is being protected from low temperatures, the time period for curing by saturation shall be one day less than the duration of the low temperature protection. Curing of concrete shall be by methods which will keep the concrete surfaces adequately wet during the specified curing period. All cast-in-place concrete in the water reservoir floor slab shall be water cured; membrane or film curing will not be acceptable.

#### 4.16.29 Water Curing

Water saturation of concrete surfaces shall begin as quickly as possible after initial set of the concrete. The rate of water application shall be regulated to provide complete surface coverage with a minimum of runoff. The application of water to walls may be interrupted for grout cleaning only over the areas being cleaned at the time, and the concrete surface shall not be permitted to become dry during such interruption.

# 4.16.30 Membrane Curing

Membrane curing compound shall be spray applied at coverage of not more than 300 square feet per gallon. Unformed surfaces shall be covered with curing compound within thirty (30) minutes after final finishing. If forms are removed before the end of the specified curing period, curing compound shall be immediately applied to the formed surfaces before they dry out. Curing compound shall be suitably protected against abrasion during the curing period.

# 4.16.31 Film Curing

Except where otherwise required to be water cured, film curing with polyethylene sheeting may be used in lieu of water curing on concrete which will be covered later with mortar or additional concrete, or will otherwise be covered or hidden from view.

Film curing shall begin as quickly as possible after initial set of the concrete. Polyethylene sheeting shall completely cover the surfaces. Sheeting shall overlap the edges for proper sealing and anchorage. Joints between sheets shall be sealed. All tears, holes, and other damage shall be promptly repaired. Covering shall be anchored continuously at edges and shall be anchored on the surface as necessary to prevent billowing.

# 4.16.32 Repairing Defective Concrete

Defects in formed concrete surfaces shall be repaired within twenty-four (24) hours, to the satisfaction of the OWNER, and defective concrete shall be replaced within forty-eight (48) hours after the adjacent forms have been removed. All concrete which is honeycombed or otherwise defective shall be cut out and removed to sound concrete, with edges square cut to avoid feathering.

Concrete repair work shall conform to Chapter 9 of ACI 301 and shall be performed in a manner that will not interfere with thorough curing of surrounding concrete. Repair work shall be adequately cured.

# 4.16.33 Finishing Formed Surfaces

Fins and other surface projections shall be removed from all formed surfaces except exterior surfaces that will be in contact with earth backfill and are not specified to be damp-proofed. A power grinder shall be used, if necessary, to remove projections and provide a flush surface.

### 4.16.34 Tie Holes

Tie holes in all formed surfaces shall be cleaned, wetted, and filled with patching mortar. Tie hole patches shall be finished flush and shall match the texture of the adjacent concrete.

# 4.16.35 Tolerances

Unless otherwise specified, tolerances for cast-in-place concrete work shall be as stipulated in ACI 347. Formed surfaces stipulated in Article 3.3.8 of ACI 347 shall be considered as Class C for all concrete work.

# 4.16.36 Surface Treatment

All concrete surfaces exposed to wastewater and/or sewer gases, inclusive of manholes, interior and exterior wall surfaces of vaults shall be coated with a minimum application of eighty (80) mils of Fosroc Epoxy Liner HBS, Poli-Brid 705, or OWNER approved equal. OWNER's approval will require submittal of product specification, history, and installation list for review at least ten (10) days prior to submission of bid package. Separate payment will not be made for surface treatment, all material, labor and resources are considered subsidiary to the item under construction.

# 4.16.37 Concrete for Pipe Blocking and Encasement

Concrete for buried blocking and encasement of pipe shall conform to the limiting requirements specified hereinbefore, except that air-entraining and water-reducing admixtures may be omitted and the cement factor and total water content may be adjusted to provide a minimum compressive strength of 3,000 psi at twenty-eight (28) days. Concrete shall have a slump of not less than two inches (2") nor more than five inches (5") when placed.

# 4.26 Fiberglass Manholes – Type B

### 4.26.0 General

#### 4.26.0.1 Scope

This section covers glass-fiber reinforced polyester (FRP) manholes and related equipment for the construction of the project. The Contractor shall furnish all materials, labor and equipment for the installation of the manholes and accessories including concrete sections as shown on the drawings and as specified in these documents. The FRP manholes are underground vertical vessels described as "fiberglass cylinders" and require poured-in-place reinforced concrete bases and reinforced concrete tops.

#### 4.26.1 Submittals

The Contractor shall submit manufacturer's history, design reports, details, tests and specifications.

#### 4.26.2 Materials

#### 4.26.2.1 Resin

The resins used shall be a commercial grade unsaturated polyester resin.

#### 4.26.2.2 Reinforcing Materials

The reinforcing materials shall be commercial Grade "E" type glass in the form of mat, continuous roving, chopping roving, roving fabric, or a combination of the above, having a coupling agent that will provide a suitable bond with the resin and leave a resin rich surface.

#### 4.26.2.3 Surfacing Materials

If reinforcing materials are used on the surface exposed to the contained substance, it shall be a commercial grade chemical-resistant glass or organic surfacing mat having a coupling agent that will provide a suitable bond with the resin and leave a resin rich surface.

#### 4.26.2.4 Fillers and Additives

Fillers, when used, shall be inert to the environment and wetwell construction. Additives, such as thixotropic agents, catalysts, promoters, etc., may be added as required by the specific manufacturing process to be used. The resulting reinforced plastic material must meet the requirement of this specification.

#### 4.26.3 Fabrication

#### **4.26.3.1 Exterior Surface**

The exterior surface shall be relatively smooth with no sharp projections. Hand-work finish is acceptable if enough resin is present to eliminate fiber show. The exterior surface shall be free of blisters larger than 2 inch in diameter, de-lamination and fiber show.

# 4.26.3.2 Interior Surface

The interior surface shall be resin rich with no exposed fibers. The surface shall be free of crazing, blisters larger than 2 inch in diameter, de-lamination and wrinkles of 1/8 inch or greater in depth. Surface pits shall be permitted up to 6 per square foot if they are less than 3/4 inch in diameter and less than 1/16 inch deep.

# 4.26.3.3 Defects Not Permitted

- a) Exposed fibers: glass fibers not wet out with resin.
- b) Resin runs: runs of resin and sand on the surface.
- c) Dry areas: areas with glass not wet out with resin.
- d) De-lamination: separation in the laminate.
- e) Blisters: light colored areas larger than 2 inch in diameter.
- f) Crazing: cracks caused by sharp objects.
- g) Pits or voids: air pockets.
- h) Wrinkles: smooth irregularities in the surface.
- i) Sharp projection: fiber or resin (any projection necessitation gloves for handling).

# 4.26.4 Physical Requirements

# 4.26.4.1 Load Rating

The complete manhole shall have a minimum dynamic load rating of 16,000 ft-lbs when tested in accordance with Section 3.5 of this specification. In order to establish this rating, the complete manhole shall not leak, crack or suffer other damage when load tested to 40,000 ft-lbs and shall not deflect vertically downward more than 1/4 inch at the point of load application when loaded to 24,000 lbs.

# 4.26.4.2 Stiffness

The manhole cylinder shall have a minimum pipe stiffness value as shown in Table 1 when tested in accordance with Section 3.5 of this specification.

Stiffness Requirements			
Length, (ft) F/dY (psi)			
3 to 9	1.26		
10 to 20	2.01		
21 to 30	3.02		
31 to 40	5.24		

# **4.26.4.3 Physical Properties**

Property (PSI)	<b>Hoop Direction</b>	<b>Axial Direction</b>
Tensile strength	18,000	5,000
Tensile Modulus	800,000	700,000

Flexural Strength	26,000 4,500	
Flexural Modulus		
(no ribs - 48", 60", 72")	1,400,000	700,000
(with ribs - 96", 144")	700,000	700,000

### 4.26.5 Placement

# 4.26.5.1 Installation

This is a general guide to placement of fiberglass manholes, the Contractor should follow procedures as directed by the manufacture and to the approval of the Owner.

- Before attempting to install any manhole, ensure excavation has been shored properly.
- Cut out manhole to set over pipe (maximum OD + one inch usual).
- Concrete base to be poured in place in trench.
- Install manhole by inserting into wet concrete base.

### 4.26.6 Testing

# 4.26.6.1 Material and Fabrication

Test shall be performed as specified in ASTM D3753, latest revision, Section 8.

#### 4.26.7 Measurement and Payment

Measurement and payment for this item will be based on the lump sum price bid. Payment will include full compensation for installation of manhole, base, connections, etc. in accordance with the specifications, Plans and /or instructions of the OWNER.

# 4.28 Sewer Line and Manhole Testing

### 4.28.0 General

#### 3.28.0.1 Scope

This Section will outline required testing for acceptance of construction of sewer lines, manholes, and other appurtenances as needed for complete and proper installation as described in the plans, details, specifications and contract documents provided.

### 4.28.1 Testing Procedure

#### 4.28.1.1 General

After the underground conduit is in place and backfilled, the Contractor shall conduct, furnishing all material, equipment and resources required, applicable tests on all new sewer systems as directed in this specification and approved by the Owner.

### 4.28.1.2 Pneumatic Exfiltration Test for Pipe

The Low Pressure Air Test procedure shall conform to the procedures described in ASTM C-828, ASTM C-924, ASTM F-1417 or other appropriate procedures, except for testing times. The test times shall be as outlined in this section. For sections of pipe less than 36-inch average inside diameter, the following procedure shall apply unless the pipe is to be joint tested. The pipe shall be pressurized to 3.5 psi greater than the pressure exerted by groundwater above the pipe. Once the pressure is stabilized, the minimum time allowable for the pressure to drop from 3.5 pounds per square inch gauge to 2.5 pounds per square inch gauge shall be computed from the following equation:

$$T = \frac{0.085 \times D \times K}{Q}$$

T = Time for Pressure to Drop 1.0 Pound per Square Inch Gauge in Seconds

 $K = 0.000419 \times D \times L$ , But Not Less than 1.0

D = Average Inside Pipe Diameter in Inches

L = Length of Line of Same Pipe Size Being Testing, in Feet

Q = Rate of Loss, 0.0015 Cubic Feet per Minute per Square Foot Internal Surface Shall be Used

Since a K value of less than 1.0 shall not be used, there are minimum testing times for each pipe diameter as follows:

Pipe Diameter (in.)	Minimum Time (sec.)	Length for Min. Time	Time for Longer
		(linear ft.)	Length (sec.)
6	340	398	0.855xLF
8	454	298	1.520xLF
10	567	239	2.374xLF
12	680	199	3.419xLF
15	850	159	5.342xLF
18	1020	133	7.693xLF
21	1190	114	10.471xLF
24	1360	100	13.676xLF
27	1530	88	17.309xLF
30	1700	80	21.369xLF
33	1870	72	25.856xLF
36	2031	66	30.634xLF

The test may be stopped if no pressure loss has occurred during the first 25% of the calculated testing time. If any pressure loss or leakage has occurred during the first 25% of the testing period, then the test shall continue for the entire test duration as outlined above or until failure. Lines with a 27-inch average inside diameter and larger may be air tested at each joint. Pipe greater than 36 inch diameter must be tested for leakage at each joint. If the joint test is used, a visual inspection of the joint shall be performed immediately after testing. The pipe is to be pressurized to 3.5 psi greater than the pressure exerted by groundwater above the pipe. Once the pressure has stabilized, the minimum time allowable for the pressure to drop from 3.5 pounds per square inch gauge to 2.5 pounds per square inch gauge shall be 10 seconds.

# 4.28.1.3 Vacuum Testing Manholes

All manholes vacuum tested shall in accordance with the ASTM C1244. The vacuum tester shall be a device approved for use by the Owner.

All lift holes and pipes entering the manhole shall be plugged prior to a vacuum being drawn and the drop over a specified time determined. The test head shall be placed at the top of the manhole in accordance with the manufacturer's recommendations. A vacuum of 10 inches of mercury shall be drawn on the manhole, the valve line of the test head closed, and the vacuum pump shut off. The time shall be measured for the vacuum to drop to 9 inches of mercury. The manhole shall pass if the time for the vacuum reading to drop from 10 inches of mercury to 9 inches of mercury meets or exceeds the values indicated below.

Manhole	Manhole Diameter (in.)				
Depth (ft.)	48	54	60	68	72
	Time (Sec.)				
<=8	20	23	28	29	33
10	25	29	33	38	41
12	30	35	39	43	49
14	35	41	46	51	57
16	40	46	52	58	65
18	45	52	59	65	73
20	50	63	65	72	81
22	55	64	72	79	89
24	59	64	78	87	97
26	64	75	85	94	105
28	69	81	91	101	113
30	74	87	98	108	121

# 4.28.1.4 Hydrostatic Exfiltration Test for Manholes

After all manholes are in place and backfilled, an exfiltration test shall be made on all manholes in the following manner:

- 1) Plug the sewer(s) entering and leaving the manhole.
- 2) Fill the manhole with water to the level directed by the Owner.
- 3) Let the water stand in the manhole for a minimum duration of four (4) hours.
- 4) Refill the manhole to the beginning level.
- 5) After one (1) hour, record the change in elevation of the water surface.

The allowable change in water surface elevation is one-eighth (1/8") inch per foot of manhole depth.

# 4.28.1.5 Hydrostatic Exfiltration Test for Sewer Pipes

After sewer pipe is in place and backfilled, and when specified by the Owner, an exfiltration test shall be made on pipe in the following manner:

- 1) Plug the lower end of the section of line to be tested.
- 2) Fill the line and the manhole at the upstream end of the line with water to two (2') feet above the crown of the line being tested.
- 3) Let the water stand in the pipe and manhole for a minimum of four (4) hours.
- 4) After the water has stood for a minimum of four hours, refill the manhole to the original depth.
- 5) After a period of one hour, record the difference in elevation of the water surface and convert into gallons.

The allowable leakage shall not exceed 8.3 gallons per inch pipe diameter per mile of pipe tested per hour.

# 4.28.1.6 Hydrostatic Test for Subaqueous Pipe Installations

After pipe is in place, and when specified by the Owner, hydrostatic testing shall be performed by infiltration or exfiltration methods as determined by the Owner.

#### **Infiltration Test:**

After pipe is in place and all backfill has been placed or fill removed to the satisfaction of the Engineer, the pipe to be tested shall be inspected by the Owner via video camera to verify the presence or absence of water within the pipe. If present, all water shall be removed from the pipe by the Contractor. Testing shall proceed after a follow up inspection of the pipe by the Owner.

Infiltration testing shall be performed in the following manner:

- 1) Place watertight plugs within the pipe or at manholes both upstream and downstream of the entire length of pipe where the water and or groundwater level is above the top of the pipe to prevent the accumulation of extraneous moisture within the pipe.
- 2) After pipes have been sufficiently plugged, the pipe shall be subjected to 'in place' hydrostatic water pressures for a period of no less than two (2) weeks.
- 3) After the testing period has expired, the Owner shall order that all plugs be removed. The Owner will then perform a visual inspection of the pipe prior to final acceptance of the installation.
- 4) Allowable infiltration leakage rate is zero (0) gallons during the minimum two week testing period.

# 4.28.1.7 Deflection Test - Mandrel Test

Deflection tests shall be performed on all flexible and semi-rigid pipe after the final backfill has been in place at least thirty (30) days according to the procedures described in these specifications:

- a) The deflection test shall be run using a rigid ball or mandrel having a diameter equal to 95% of the nominal inside diameter of the pipe. No allowances shall be made for out-of-roundness or any other deviation from the nominal pipe diameter.
- b) The test shall be performed without mechanical pulling devices.
- c) No pipe shall exceed a deflection of five (5%) percent.

### 4.28.2 Test Results

All tests performed on the sanitary sewer system shall be presented to the Owner. Test results shall indicate conformance/nonconformance to these Technical Specifications.

### 4.28.3 Nonconformance

Should the system fail exfiltration or deflection tests, the Contractor shall find and repair any and all leaks or discrepancies, at no additional cost to the Owner, and re-test. All costs associated with material, equipment and labor required for the testing of the system shall be included in the unit cost bid for each item.

# 4.28.4 Safety Provisions

Plug used to close the pipe for either air or exfiltration testing must be securely braced to prevent the unintentional release of a plug which can become a high velocity projectile.

Gages, air piping manifolds and valves shall be located at the top of the ground. No one shall be allowed to enter a manhole where a plugged pipe is under pressure.

# 4.28.5 Test Equipment

The test equipment used with either method of air pressure testing shall be certified as satisfactory by the Owner at the beginning of the project. The inspector may at any time require a calibration check of the instrumentation used.

# 4.28.6 Manufacturer's Instructions

The Contractor shall perform the air testing in strict accordance with the manufacturer's instructions for the equipment used.

# 4.28.7 Measurement and Payment

All work and material furnished under this section is considered subsidiary to the various pay items; therefore, no additional payment shall be made for material furnished or work done under this section.

# 4.46 - Site Clean-up

# 4.46.0 General

### 4.46.0.1 Scope

This section of the specifications outlines the responsibilities of site clean-up. Any work performed under this contract shall include site clean-up.

Areas in paved street roadways or alleys disturbed during construction shall be scraped and broomed, as necessary, and left in a clean and neat condition to the satisfaction of the OWNER. No direct compensation will be made for this work.

Areas beyond the paved street roadway or alley disturbed during construction shall be scraped, raked, graded or broomed, as necessary, and left in a clean and neat condition to the satisfaction of the OWNER. Compensation for this work shall be at the hourly rate as bid on this item in the bid schedule.

All site clean-up shall be done before final acceptance of construction will be considered.

### 4.46.1 Trench Spoil Removal

Trench spoil is either spoil material removed from the trench by the OWNER or unsatisfactory backfill material left on site by the OWNER outside of the trench repair boundaries. This material will not include Temporary Backfill. The CONTRACTOR will remove and dispose of this material unless otherwise directed by the OWNER.

# 4.46.2 Measurement and Payment

#### 4.46.2.1 Measurement

- a) Hourly Site Clean-up: Prior to initiation of work on the site, the CONTRACTOR shall meet with the City of San Angelo Inspector to define the limits of site clean-up within the general area of the job site. The CONTRACTOR and the City of San Angelo Inspector shall come to a mutual agreement as to the amount of clean-up required outside the job site limits and set a reasonable time for the amount of hours required to clean-up.
- b) Trench Spoil Removal: Measurement shall be for each cubic foot removed as determined by the City of San Angelo Inspector either by volume of trench work, trucked volume, or physical measurement.

#### 4.46.2.2 Payment

All work and material furnished under this section is considered subsidiary to the various pay items; therefore, no additional payment shall be made for material furnished or work done under this section.