CITY OF SAN ANGELO, TEXAS

SPECIFICATIONS

FOR

2017 SULPHUR DRAW WASTEWATER IMPROVEMENTS

AUGUST, 2017

Enprotec / Hibbs & Todd
402 Cedar, Abilene, Texas 79601
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PE Firm Registration No. 1151
PG Firm Registration No. 50103
RPLS Firm Registration Nos. 10011900 & 10007300

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2017 SULPHUR DRAW WASTEWATER IMPROVEMENTS
PROJECT SPECIFICATIONS

TABLE OF CONTENTS

CITY OF SAN ANGELO

2017 SULPHUR DRAW WASTEWATER IMPROVEMENTS
PROJECT SPECIFICATIONS

TABLE OF CONTENTS

continued

TECHNICAL SPECIFICATIONS

4.1 – General Construction Notes

4.1.0 General

All existing underground utilities shown on drawings were obtained from the best information available but are not guaranteed to be complete or definite. CONTRACTOR shall request the exact location of existing facilities by calling the Texas One-Call Locate Service [811] and the City of San Angelo Water Utilities Department [(325) 657-4295] at least 48 hours prior to commencing work. CONTRACTOR is responsible for all damages which occur from the failure to exactly locate and preserve underground utilities.

CONTRACTOR shall "pothole" all underground utility crossings ahead of the construction crews to locate and verify exact existing vertical elevations. CONTRACTOR shall notify the OWNER immediately upon identification of a potential conflict.

Construction shall be in compliance with §217.53 of the current TCEQ regulations in regard to installation method, material type and separation distance between water mains and wastewater collection facilities.

If cultural materials are encountered during construction, work shall immediately cease in the area of discovery. Work may continue in the project area where no cultural materials are present. The CONTRACTOR shall immediately notify the OWNER and the Texas Historical Commission at (512) 463-6100.

Clearing of trees along the project route shall only be conducted between September 1 and February 28 and must be approved by the OWNER prior to removal. Trimming of trees along the project route shall be performed by a licensed arborist, neatly and with utmost care for the health of the tree. Coordinate removal and trimming with OWNER prior to work.ja

CONTRACTOR shall protect existing trees along the project route to the extent practical.

Work within the banks of the North Concho River shall comply with the requirements of Army Corps of Engineers Nationwide Permit 12 and the project Aquatic Resource Protection Plan.

All dimensions shown are approximate and are to be verified by the CONTRACTOR. Horizontal or vertical alignment changes are to be approved by the OWNER.

Any relocation of an existing utility not shown on the drawings, whether temporary or permanent, shall be approved by the OWNER prior to relocation and shall conform to all applicable governing standards and specifications.

Utility service lines are not generally shown on drawings. CONTRACTOR shall anticipate that such service lines exist and take measures to identify and protect them during construction. Damaged service lines shall be promptly repaired at no additional cost to the OWNER.

CONTRACTOR shall be responsible for safeguarding and protecting all materials and equipment stored on or off the job-site in a safe and workman-like manner, during and after working hours, until job completion.

CONTRACTOR shall prepare and submit a Schedule for all phases of construction and provide an updated Schedule following any significant deviation from the Schedule. Phasing of construction shall generally proceed as follows:

Install Lift Station and Line "B" (Force Main).

Install Line "C" (30" Gravity Main).

Install Line "A" (18" Gravity Main).

Rehabilitate Existing Gravity Mains and Manholes.

Abandon Existing Gravity Mains and Manholes.

Work within the North Concho River and the Santa Fe Park Golf Course must be completed prior to February 28, 2018.

CONTRACTOR shall schedule and coordinate work with the OWNER as far in advance as practical to minimize disturbance to residents and businesses along the project route.

CONTRACTOR shall prepare and submit a bypass pumping plan (BPP) for each phase of construction. Implementation and maintenance of bypass pumping operations shall be the responsibility of the CONTRACTOR throughout construction.

The OWNER will designate locations along the project route for CONTRACTOR's use in storage and staging equipment and materials.

CONTRACTOR shall not store materials or equipment or place excess excavated material on private property without prior written agreement with the property owner.

CONTRACTOR shall promptly remove and legally dispose of all cut vegetation, stumps, rocks, excavated material and other debris not designated to remain on the project site.

All areas disturbed by the CONTRACTOR shall be restored to their original or better condition.

Existing improvements, including but not limited to landscaping, fences, mailboxes, culverts, headwalls, sidewalks, utility pipelines and drainage structures, which are damaged, removed or altered during construction but do not have an individual bid item, shall be repaired or replaced by the CONTRACTOR, in the same location and in a condition as good or better than found, at no additional cost to the OWNER.

In areas where existing landscaping requires removal, CONTRACTOR shall contact resident and obtain desired location to relocate.

CONTRACTOR shall replace topsoil and reseed all areas disturbed by construction activities and not specified for other surface replacement.

CONTRACTOR shall restore pavement to as good or better than the condition prior to construction, to the satisfaction of the OWNER.

CONTRACTOR shall review Geotechnical Report and become familiar with local underground conditions expected to be encountered on this project. All excavation is considered "unclassified" and is subsidiary to the various bid items of the project.

CONTRACTOR shall prepare and submit a trench safety system plan (TSSP) for all phases of construction. Implementation and maintenance of trench protection shall be the responsibility of the CONTRACTOR throughout construction.

CONTRACTOR shall provide sheeting, shoring and bracing as necessary to adequately protect workmen and existing structures and utilities during all phases of construction in accordance with OSHA requirements.

CONTRACTOR shall cover open excavations in trafficked areas with anchored ½" steel plates during non-working hours. Open excavations in non-trafficked areas shall be otherwise protected.

Use appropriate compaction equipment for the type of soil encountered. Clay backfills normally require consolidation by sheep's-foot roller whereas sand and gravel can be compacted with vibratory equipment. The OWNER may reject specific types of equipment on site as soil conditions may vary and as location warrants (ie. Proximity to existing structures).

If ground water is encountered the CONTRACTOR shall use pumps and/or well points to dewater the area to allow underground construction. Cost of dewatering shall be included in the unit bid for installation of proposed line or structure.

CONTRACTOR shall test materials to be used for backfilling and adjust moisture content to specified levels by adding water or drying soils as necessary and as specified.

The CONTRACTOR is responsible for scheduling construction materials testing through the designated field representative 24 hours prior to testing. CONTRACTOR is responsible for adhering closely to testing schedule to avoid any delays in the field.

CONTRACTOR shall verify that bench marks have not been disturbed and notify the OWNER immediately upon identification of a potential issue.

CONTRACTOR shall keep streets, rights-of-way and the work area clean of dirt, mud and other objectionable debris.

CONTRACTOR shall minimize the generation of nuisance dust by watering and/or sweeping as needed.

CONTRACTOR shall incorporate measures during construction to minimize the generation of nuisance odors from the existing wastewater collections system and construction activities.

CONTRACTOR shall follow all City Ordinances regarding noise and environmental impacts.

CONTRACTOR shall keep accurate records of as-built conditions and provide to the OWNER to aid in the preparation of as-built record drawings following completion of all construction.

CONTRACTOR shall provide to the OWNER all material and equipment operation and maintenance (O&M) manuals, spare parts lists, etc., as recommended by the equipment manufacturers and required by the project documents, prior to final acceptance of the work.

4.1.1 Limits of Construction

CONTRACTOR shall take photo/video evidence of existing conditions of the project site area prior to construction and submit to the OWNER prior to mobilization of equipment or materials.

Limit operations to within the confines of the construction work limits shown on the drawings and designated by the OWNER.

Limit the storage of equipment, materials, stock piles, etc. to one (1) construction week along construction route within the public right of way. Storage longer than one (1) week shall be located in OWNER designated areas.

When tunneling or auguring is shown in plans, access (open cut) from surface is prohibited. The exception to this restriction is for emergency situations where action is required to safe guard the work in progress or other existing utilities. In this case, the OWNER is to be immediately notified of additional traffic control procedures and any other necessary actions that will be taken until the situation has been rectified.

4.1.2 Traffic Notes

CONTRACTOR shall prepare and submit a traffic control plan (TCP) for each phase of construction. Implementation and maintenance of traffic controls shall be the responsibility of the CONTRACTOR throughout construction.

CONTRACTOR shall provide and install traffic control devices in conformance with the Texas Manual on Uniform Traffic Control Devices (TMUTCD), latest edition, during construction.

When applicable, CONTRACTOR will be responsible for maintaining continuous signal operation at signalized intersections, for adjusting and/or relocating existing traffic signal equipment or providing, installing, and maintaining temporary signal equipment as needed for construction and to provide line-of-sight signal indications, and for immediately replacing and/or repairing any traffic signal equipment, cables, or conduit that is cut or damaged.

The construction warning signs and end of construction signs shall be placed at project limits and shall remain in place throughout the duration of the construction.

CONTRACTOR shall maintain traffic in each direction by means of flagmen or detour.

CONTRACTOR shall provide and maintain pedestrian safety fences and barricades at all times at each site where pedestrian traffic is evident.

CONTRACTOR shall promptly place and maintain temporary cold-mix paving on pavement cuts released to general traffic until final pavement is placed.

CONTRACTOR must notify businesses and residents impacted by construction at least one week prior to construction start in their area.

A notice, prepared by the CONTRACTOR and approved by the OWNER, shall be hand delivered by the CONTRACTOR to all residents and businesses within the vicinity of construction notifying them of the proposed construction and possible disruptions in service to water, sewer, roads, access, etc. Notice shall include dates of work and numbers to contact in case of any questions.

CONTRACTOR shall coordinate with property owners to determine an appropriate time to cross driveways and provide alternate means of access during construction activities in one or more of the following methods: (1) anchored ½" steel plates (2) backfilling immediately after construction and placing caliche surface for temporary driveway purposes. Cost for notifications and maintaining access shall be considered incidental to the various bid items.

4.1.3 Drainage Notes

CONTRACTOR shall prepare and submit a storm water pollution prevention plan (SWPPP) for all phases of construction. Implementation and maintenance of stormwater controls shall be the responsibility of the CONTRACTOR throughout construction.

Adequate drainage shall be maintained at all times during construction and any drainage ditch or structure disturbed during construction shall be restored to the satisfaction of the OWNER.

No excess excavated material shall be deposited in low areas or along natural drainage ways, unless specifically authorized by OWNER in writing.

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.

An account of all water usage is required and the CONTRACTOR is responsible for any deposit on metering equipment. The OWNER will place a hydrant meter in a suitable location on the project route and relocate the hydrant along the route as requested by the CONTRATOR. The CONTRACTOR shall furnish necessary temporary pipe, hose, nozzles, and tools and shall perform all necessary labor required to connect to hydrant meter. Special hydrant wrenches shall be used for opening and closing fire hydrants. In no case shall pipe wrenches be used for this purpose.

The CONTRACTOR shall adhere to backflow prevention requirements when using the OWNER provided meter. Unnecessary waste of water will not be tolerated. CONTRACTOR shall be responsible to record and report meter readings a minimum of once a month to OWNER.

Water used to correct deficiencies or for re-testing of a Work failing previous tests may be charged to the CONTRATOR, at the discretion of the 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. CONTRACTOR cellular mobile phone is acceptable.

4.2.5 Sanitary Facilities

The CONTRACTOR shall furnish temporary sanitary facilities at the site for the needs of all construction workers and others 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 a site-specific Traffic Control Plan (TCP), overlaid on the construction plans, an aerial image or other suitable media. The TCP shall be certified by a Professional Engineer, registered in the State of Texas, be in general compliance with the Texas Manual on Uniform Traffic Control Devises, (TMUTCD) and show all necessary control measures in detail to effectively and safely control traffic and pedestrians around the impacted area. Plans shall be submitted to and approved by the OWNER prior to work commencing within the public right of way.

The CONTRACTOR shall conduct his work to interfere as little as possible with public travel, both vehicular and 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 construction 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. Noise shall be minimized during the hours of 10:30 PM to 7:00 AM.

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 applied 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. Water used for dust control in reasonable amounts will be provided by the OWNER at no charge to the CONTRACTOR.

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 provide OWNER with a Storm Water Pollution Prevention Plan (SWPPP) and submit all required documentation, including but not limited to, "Notice of Intent" (NOI), "Notice of Termination" (NOT), and "Notice of Change" (NOC) the Texas Commission on Environmental Quality (TCEQ). The CONTRACTOR shall prepare and comply with the Storm Water Pollution Prevention Plan and Storm Water Management Plan. The plans shall be certified by a Professional Engineer, registered in the State of Texas, and show all necessary control measures in detail to effectively control erosion and sediment. 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 and shall remain in place until after construction is complete and the site has been stabilized.

The CONTRACTOR shall provide silt fencing, straw waddles 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.

4.2.17 Measurement and Payment

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

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 is considered "unclassified" and subsidiary to the various bid items of the project. 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.

EXHIBIT A, Geotechnical Investigation Report:
CONTRACTOR shall review Geotechnical Report and become familiar with local underground conditions expected to be encountered on this project. Geotechnical Report and Bore Logs are for information and reference use only. Bore logs are not intended to represent all materials that may be encountered throughout the project area.

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.

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 ± 2% of 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 windrows 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 ± 2% of 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 crushed stone or 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.

Bedding material for the installation of water and sewer mains shall be crushed stone or pea gravel that will remain firm and not permit displacement of the pipe either during pipe laying or backfilling or following completion of construction. Bedding material shall be from an approved bedding material source per the List of Approved Bedding Material Suppliers or meet the following gradation when tested in accordance with TXDOT Designation: TEX-200-F, Part I, and be approved by the City Engineer:

COSA Bedding Material Gradation	
Sieve Size	Cumulative % Retained
1/2"	0
3/8"	0-20
#4	40-90
#10	95-100
#20	99-100

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 backfill cover over the top of the pipe, including couplings or bells, of thirty inches (30") for pipe diameters of 12-inches and less and thirty-six inches (36") for pipe diameters larger than 12-inches.

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	Maximum Trench width
< = 16"	Pipe OD plus 12"	Pipe OD plus 18"
> 16"	As specified by pipe manufacturer and approved by the OWNER	

4.3.15 Compacted Backfill

All backfill shall be compacted to a minimum of ninety-five percent (95%) Modified Proctor density at ± 2% of optimum moisture content as determined by ASTM D1557.

Backfill beneath surface structures, streets, fills or embankments shall be Flex Base, placed in eight inch (8") un-compacted thick layers and compacted at ± 2% of optimum moisture content to ninety-five percent (95%) Modified Proctor density as determined by ASTM D1557.

The CONTRACTOR shall be responsible for providing all Proctor data from source locations and pits used for backfill. The OWNER reserves the right to conduct density tests at any time, at the OWNER's expense.

In other areas and 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 Backfill Around Structures

Backfill material within 24-inches around structures shall be Flex Base, placed in eight inch (8") un-compacted thick layers and compacted at ± 2% of optimum moisture content to ninety-five percent (95%) Modified Proctor density 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 will not be allowed.

Where indicated on the Plans, backfill around structures shall be lean concrete flowable fill or cement-stabilized sand backfill with 2-sacks of cement per cubic yard of sand, consolidated with vibratory equipment.

No backfill shall be placed 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 replacement shall be done by the CONTRACTOR as indicated on the Plans.

4.3.22 Concrete Blocking

Concrete blocking shall be placed at all fittings (bends, tees, wyes, crosses, plugs, etc.) in the force main. 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 line.

4.3.23 Measurement and Payment

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

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.

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 by the OWNER.

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 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 will be paid consistent with progress of the Work at the unit price per the Bid Form for Trench Safety System for the actual quantity of units installed as measured by the linear footage along the centerline of the trench.

4.5 - Seeding for Erosion Control

4.5.0 General

4.5.0.1 Scope

This item shall govern for preparing ground, providing for sowing of seeds, seed bed fertilizer, watering, mulching with straw, hay, cellulose fiber, hydromulch or and other management practices on all areas disturbed by the CONTRACTOR's operations. CONTRACTOR shall replace cover of all disturbed areas with the same type of vegetation in accordance with this item.

4.5.1 Materials

a) **Seed** - All seed must meet the requirements of the Texas Seed Law including labeling requirements for showing pure live seed (PLS = purity x germination), name and type of seed. Seed furnished shall be of the previous season's crop and the date of analysis shown on each bag shall be within nine months of the time of use on the project. Each variety of seed shall be furnished and delivered in separate bags or containers. A sample of each variety of seed shall be furnished for analysis and testing when directed by the OWNER. Buffalograss shall be treated with a dormancy method approved by the OWNER. The species and varieties of seed shall as specified herein.

b) **Water** - Water shall be furnished by the CONTRACTOR and shall be clean and free from any impurities which will prohibit or hinder its use as specified.

c) **Mulch** -

i. Straw Mulch or Hay Mulch: Straw mulch shall be oat, wheat or rice straw. Hay mulch shall be prairie grass, Bermuda grass or other hay as approved by the OWNER. The straw mulch or hay mulch shall be free of Johnson grass or other noxious weeds and foreign materials. It shall be kept in a dry condition and shall not be molded or rotted.

ii. Cellulose Fiber Mulch: It shall meet the requirements of and be approved by the OWNER. A list of pre-tested and approved materials can be obtained from the Texas Department of Transportation, Director of Maintenance and Operations.

iii. Soil Retention Mulch: It shall meet the requirements of and be approved by the OWNER.

iv. The mulch shall be designed for use in conventional mechanical planting, hydraulic planting of seed or hydraulic mulching of grass seed, either alone or with fertilizers and other additives. The mulch shall be such that, when applied, the material shall form a strong, moisture-retaining mat without the need of an asphaltic binder. It shall be kept in a dry condition and shall not be molded or rotted.

d) **Soil Retention Blanket** - Soil retention blanket shall conform to the requirements of TXDOT Specification Item 169, "Soil Retention Blankets".

e) **Tacking Agents** - Tacking agents for straw or hay mulch shall be SS-1, unless shown otherwise on the Plans. A biodegradable tacking agent may be used in lieu of the SS-1 tacking agent when approved by the OWNER.

4.5.2 Construction Methods

After designated areas have been completed to the lines, grades and cross sections shown on the Plans and as provided for in other items of this contract, seeding shall be performed in accordance with the requirements hereinafter described. Unless otherwise approved by the OWNER, all areas to be seeded shall be cultivated to a depth of at least four (4) inches, unless the existing soils conditions are deemed acceptable by the OWNER for seeding. The seed beds shall be cultivated sufficiently to reduce the soil to a state of good tilth when the soil particle on the surface are small enough and lie closely enough together to prevent the seed from being covered too deeply for optimum germination. Cultivation of the seed bed will not be required in loose sand where depth of sand is four inches or more.

The cross section previously established shall be maintained throughout the process of cultivation. Any necessary reshaping shall be done prior to any planting of seed.

Planting Season and Seed Mixes - If construction is completed between February 1st to May 15th, or after a Cool Season Planting has been made, then the Warm Season Seeding Mixture should be planted. If construction is completed between May 16th to August 31st, Warm Season Seeding Mixture should be planted, supplemented with Foxtail Millet at 20 lbs/acre, until the appropriate time for the Cool Season Seed Mixture can be planted. If construction is completed between September 1st to November 30th, then the Cool Season Planting of Red Winter Wheat and the Warm Season Seeding Mixture should be conducted. If construction is completed between December 1st to January 31st, then the Cool Season Planting of Annual Rye Grass and the Warm Season Seeding Mixture should be conducted.

The pure live seed (PLS) planted per acre shall be of the type specified, with the mixtures as shown in tables below, except as noted on the Plans.

Warm Season Seeding Mixture		
Common Name	**Scientific Name**	**PLS/acre**
Green Sprangletop	Leptochloa dubia	0.7
Sideoats Grama (Haskell)	Bouteloua curtipendula	2.2
Buffalograss	Buchloe dactyloides	6.4
Little Bluestem	Schizachyrium scoparium	1.4
K-R Bluestem	Bothriochloa ischaemum	0.8

Cool Season Seeding Mixture		
Common Name	**Scientific Name**	**PLS/acre**
Annual Rye Grass	Lolium Multiflorum	4.0
Western Wheatgrass	Pascopyrum smithii	10.0
Wheat (Red, Winter)	Triticum aestivum	22.0

Drill Seeding - The seed or seed mixture, in the quantity specified, shall be uniformly distributed over the areas shown on the Plans or where directed by the OWNER. All varieties of seed, as well as fertilizer, may be distributed simultaneously provided that each component is uniformly applied at the specified rate. Seed shall be drilled at a depth of from 1/4 to 3/8 inch utilizing a pasture or rangeland type drill. All drilling shall

be along the contour of the slope. After planting, the area shall be rolled with a roller integral to the seed drill, or a light corrugated drum roller or another type of roller approved by the OWNER. All rolling of slopes shall be on the contour of the slopes.

Mulching - Mulch shall be applied to all seeded areas within forty-eight (48) hours after all drill seeding operations have been completed. Material shall be applied from two separate and opposite (180 degrees) directions to prevent shadowing and to provide an even coverage. Mulching application shall be such that the ground surface, when viewed from opposite directions, is not visible. Under no circumstances is seed to be applied in the mulch mix.

Level to Gently Sloping Area Mulching. This area shall be mulched with a spray-applied cellulose fiber mulch with pre-mixed tackifier and fertilizer (see following section). The mulch shall be applied at 2,500 pounds per acre. The mulch shall have the following characteristics and shall be as manufactured by Profile Products, or other approved equal:

- Materials: Cellulose fiber, polymer tackifier, dark green dye.
- pH range: 7.0 ±2
- Moisture Content: 12 ±3% maximum
- Organic Content: 90.0 ±3%
- Ash Content: 10.0 ±3%
- Tackifier: 3% polymer tackifier
- Water Holding Capacity: 1050% minimum

Side-Slope Area Mulching. This area shall be mulched with a spray-applied bonded fiber matrix wood fiber with pre-mixed tackifier and crimped polyester fiber. The mulch shall provide for a strong mechanical and chemical bond. The mulch shall be applied at 3,000 pounds per acre. The mulch shall have the following characteristics and shall be as manufactured by Profile Products (Conwed 3000), or other approved equal:

- Materials: Wood fiber, crimped polyester fibers, polysaccharide cross-linked hydro-colloid polymer tackifier, dark green dye.
- pH range: 4.8 ±2
- Moisture Content: 12 ±3% maximum
- Degradable Crimped Polyester Fibers: 5 ±1%
- Polysaccharide Crosslinked Hydro-colloid Polymer Tackifier: 10 ±1%
- Wood Fiber Content: 85% maximum
- Organic Content: 95% minimum
- Ash Content: 5.0 ±1%
- Water Holding Capacity: 1500% minimum

Water - Water shall be supplied to the seeded areas with adequate moisture (three inches (3") to four inches (4") penetration) at ten (10) day intervals, if needed, for seed germination and plant growth until accepted by the OWNER. Water shall be spray applied to the seeded areas in a manner which will prevent erosion of the soil. CONTRACTOR shall furnish and apply all water.

Fertilizer - All fertilizer utilized shall be provided with the manufacture's label which presents the percent of nitrogen, phosphoric acid and potash nutrients, as determined by the methods of the Association of Official Analytical Chemists. The fertilizer is subject to testing by the Texas A&M Feed and Fertilizer Control Service in accordance with the

Texas Fertilizer Law. Testing will be conducted at the expense of the OWNER unless the supplied fertilizer fails to meet the minimum specified content, in which case testing will be at the expense of the CONTRACTOR.

The fertilizer shall be 16-8-8 (percent of nitrogen, phosphoric acid and potash nutrients) unless otherwise specified on the Plans. The fertilizer shall be applied at the rate of 125 pounds per acre. The CONTRACTOR shall have the option of providing a fertilizer of a different analysis, if approved by the OWNER. However, the amount of each nutrient specified shall not be less than that specified.

Fertilizer shall be in an acceptable condition for distribution and shall be applied uniformly over the specified area and at the rate shown on the Plans. Distribution of fertilizer shall be approved by the OWNER. Limit fertilizer application if precipitation is forecasted within 24 hours of application, or as specified via label instructions. (TPDES GP TXR040000)

4.5.3 Establishment of Stand and Acceptance

Upon completion of the site preparation, mulching, fertilizing, seeding and maintenance of the seeded areas, the OWNER will observe the seeded areas periodically to determine the establishment success. The OWNER will consider soil coverage, purity of grass stand and maturity of the plants.

The OWNER will determine that a grassed area is established upon fulfillment of the following conditions:

a) The permanent grass stand uniformly covers the planting area, with no exposed soil areas more than thirty-six inches (36") across in any dimension.

b) The permanent grass stand is free of over-topping weed species which would compete for sunlight, moisture and nutrients. In addition, no area of pure weed species greater than thirty-six inches (36") across any dimension shall occur within a permanent grass stand.

c) The majority of the grass plants in a stand shall have a well-established root system to survive if irrigation is discontinued.

Establish the permanent grass stand before October 1st to preclude the need to perform Cool Season seeding. In the event a Cool Season seeding must be performed, the Warm Season Seeding Mixture may be applied in conjunction with the Cool Season seeding with prior approval of the OWNER. Upon final acceptance of the work under this contract, the OWNER will assume responsibility of maintaining the grassed areas.

4.5.4 Measurement and Payment

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

4.6 - Flexible Base

4.6.0 General

4.6.0.1 Scope

The work covered by this section includes all necessary operations and materials involved with placing a flexible base or foundation course for surface course or other base courses and for pipe backfill zones. The flexible base shall be composed of crusher-run broken stone; and shall be constructed as herein specified in one or more courses in conformity with the typical sections shown on the Plans and to the lines and grades as established by the OWNER.

4.6.1 Material

4.6.1.1 Source

The material source shall be approved by the OWNER.

4.6.1.2 Crushed Stone

The material shall be crushed and shall consist of durable particles of stone mixed with approved binding material. Material shall meet all the provisions of Item 247, TxDOT specifications and shall be Type A, Grade 2. It shall consist of crushed limestone with the following physical requirements:

Grading Requirements		
Percent Retained		
1-3/4	**No. 4**	**No. 40**
0-10	45-75	60-85
Atterberg Limits		
LL	**PI**	
40 Maximum	12 Maximum	

4.6.2 Construction Methods

4.6.2.1 Preparation of Subgrade

The roadbed shall be excavated and shaped in conformity with the typical sections and to the lines and grades as established by the OWNER. All excess base material, sacrificial backfill and/or unstable or otherwise objectionable material shall be removed from the subgrade and replaced with approved material. All holes, ruts, and depressions shall be filled with approved material, and if required, the subgrade shall be thoroughly wetted with water and reshaped and rolled to the extent directed in order to place the subgrade in an acceptable condition to receive the base material. Subgrade shall be compacted to a minimum depth of eight inches (8") and a minimum ninety-five percent (95%) of Modified Proctor density at ± 2% of optimum moisture content.

4.6.2.2 Compaction

Flexible base material shall be placed in uniform horizontal layers and compacted by mechanical means to a minimum of 95% Modified Proctor density at ± 2 percentage points optimum moisture content.

4.6.3 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 unless specified.

4.7 - Asphaltic Concrete Pavement

4.7.0 General

4.7.0.1 Scope

The work covered by this section includes the placement of a surface course composed of a compacted mixture of mineral aggregate and asphaltic material. The pavement shall be constructed on the previously approved flexible base or concrete cap. For trench repairs greater than sixty inches (60") wide, asphalt shall be placed using a lay down machine.

4.7.1 Material

4.7.1.1 Prime Coat

The prime coat shall be of TXDOT MC-30 asphalt applied at the rate of 0.25 to 0.35-gallon per square yard of surface, unless otherwise approved by the OWNER.

4.7.1.2 Tack Coat

The tack coat shall meet the requirements of TXDOT Item 300, "Asphalts, Oils, and Emulsions", applied at a rate of 0.15 gallons per square yard to saw-cut edges, adjacent concrete or other appurtenances within the confines of the paved area.

4.7.1.3 Asphalt Concrete Material

The asphaltic concrete surface material shall be of TXDOT Type D hot mix asphaltic concrete or Type D hot mix – cold laid, as approved by the OWNER.

4.7.2 Equipment and Machinery

4.7.2.1 General

It shall be the responsibility of the CONTRACTOR to assure that all equipment and machinery are of a type approved by the OWNER. Equipment shall include the spreading and finishing machine, motor grader, trench roller, and vibratory steel wheel roller.

Alternate equipment which will consistently produce satisfactory results and may be used if approved by the OWNER.

4.7.3 Inspection

4.7.3.1 General

It will be the CONTRACTOR's responsibility to provide safe and accurate means to enable inspection forces to take all required samples and to provide permanent means for checking the output of any specified metering device and to perform these calibration checks as required by the OWNER.

4.7.4 Construction Methods

4.7.4.1 General

It shall be the responsibility of the CONTRACTOR to produce, transport, place, and compact the specified paving mixture in accordance with these

specifications and without delay to the lay-down operation.

If, after being discharged from the mixer and prior to placing, the temperature of the asphaltic mixture is fifty degrees (50ºF) or more below the temperature established by the OWNER, all or any part of the load may be rejected and payment will not be made for the rejected material.

4.7.4.2 Method A - Hot Mix Asphaltic Concrete Pavement

Place as follows:

a) Site Preparation:
All excavation and backfill shall be complete as otherwise specified in this contract. Sacrificial backfill and existing material, paving, etc. shall be removed to the extents defined in the trench repair detail. Sacrificial backfill shall be removed such that the resulting surface is smooth and uniform. All high areas shall be cut to the desired depth and all low areas shall be filled with processed flexible base and compacted. Once the sacrificial backfill has been removed the surface shall be compacted with a vibratory steel wheel roller (minimum 1-1/2 tons) to provide a smooth, uniform compacted surface. All holes, ruts, depressions and high spots shall be filled with approved materials. After correcting all deficiencies (holes, ruts, depressions, etc) the surface shall be re-compacted until the smooth, uniform surface is achieved. If pavement borders were not previously saw cut, they shall be saw cut providing an area of uniform width and smooth edges for the ultimate placement of the surface course.

b) Prime Coat:
Before the prime coat is applied, the surface upon which the tack coat is to be placed shall be cleaned thoroughly, by sweeping or other approved methods, to the satisfaction of the OWNER. If deemed necessary by the OWNER, the surface shall be lightly sprinkled just prior to application of the asphaltic material. The asphaltic material (prime coat) shall be applied smoothly and evenly on the clean surface by an approved pressure distributor. The CONTRACTOR shall provide all necessary facilities for determining the temperature of the asphaltic material in all of the heating equipment and in the distributor, for determining the rate at which it is applied, and for securing uniformity at the junction of two distributor loads. The prime coat shall be allowed to cure for a period of not less than twenty-four (24) hours.

All storage tanks, piping, retorts, booster tanks, and distributors used in storing or handling asphaltic material shall be kept clean and in good operating condition at all times. They shall be operated in such manner that there will be no contamination of the asphaltic material by foreign material. It shall be the responsibility of the CONTRACTOR to provide and maintain in good working order a recording thermometer at the storage heating unit at all times. The distributor shall have been recently calibrated and the OWNER shall be furnished an accurate and satisfactory record of such calibration. After beginning of the work, should the yield on the asphaltic material applied appear to be in error, the distributor shall be calibrated in a manner satisfactory to the OWNER

before proceeding with the work.

The OWNER will select the temperature of application based on the temperature-viscosity relationship. The recommended range for the viscosity of the asphalt is 100 to 125 centistokes. Hot Mix cannot be produced at more than 300º F The CONTRACTOR shall apply to roadway before it reaches 260º F.

The CONTRACTOR shall be responsible for the maintenance of the surface until the work is accepted by the OWNER.

No traffic, hauling, or placement of any subsequent courses shall be permitted over the freshly applied prime coat until authorized by the OWNER.

c) Placing:
The surface coat shall be placed in two inch (2") horizontal layers and shall be compacted to ninety percent (90%) of the theoretical density. The OWNER reserves the right to conduct density tests at any time, at the OWNER's expense. The asphaltic mixture shall be dumped and spread on the approved prepared surface in such a manner that when properly compacted, the finished pavement will be smooth, of uniform density, and will meet the requirements of the typical cross-sections and the surface test. During the application of asphaltic material, care shall be taken to prevent splattering of adjacent pavement, curb and gutter, and structures.

Adjacent to flush curbs, gutters, liners, and structures, the surface shall be finished uniformly high so that when compacted it will be slightly above the edge of the curb and flush with structures.

Prior to placement of the asphaltic concrete materials, the compacted backfill shall be primed. Where a concrete cap is placed, it shall be allowed to cure for seventy-two (72) hours; then a tack coat shall be applied.

d) Compacting:
The pavement shall be compacted thoroughly and uniformly with dual drum rollers to obtain the density, stability, and the cross section of the finished paving mixture meeting the requirements of the Plans and Technical Specifications and the approval of the OWNER.

All rollers must be in good mechanical condition. Necessary precautions shall be taken to prevent the dropping of gasoline, oil, grease, or other foreign matter on the pavement, either when the rollers are in operation or when standing.

Regardless of the method of compaction control followed, all rolling shall be completed before the mixture temperature drops below 175ºF.

The edges of the pavement along curbs, headers, and similar structures, and all places not accessible to the roller, or in such positions as will not allow thorough compaction with the rollers, shall be thoroughly

compacted with lightly oiled tamps.

4.7.4.3 Method B - Hot Mix - Cold Laid Asphaltic Concrete

Place as follows:

a) Site Preparation:
All excavation and backfill shall be complete as otherwise specified in this contract. Sacrificial backfill and existing material, paving, etc. shall be removed to the extents defined in the trench repair detail. Sacrificial backfill shall be removed such that the resulting surface is smooth and uniform. All high areas shall be cut to the desired depth and all low areas shall be filled with processed flexible base and compacted. Once the sacrificial backfill has been removed the surface shall be compacted with a vibratory steel wheel roller (minimum 1-1/2 tons) to provide a smooth, uniform compacted surface. All holes, ruts, depressions and high spots shall be filled with approved materials. After correcting all deficiencies (holes, ruts, depressions, etc) the surface shall be re-compacted until the smooth, uniform surface is achieved. If pavement borders were not previously saw cut, they shall be saw cut providing an area of uniform width and smooth edges for the ultimate placement of the surface course.

b) Tack Coat:
Before the prime coat is applied, the surface upon which the tack coat is to be placed shall be cleaned thoroughly, by sweeping or other approved methods, to the satisfaction of the OWNER. The surface shall be given a uniform application of tack coat using asphaltic materials of this specification. The tack coat shall be applied with an approved sprayer at a rate not to exceed 0.05-gallon residual asphalt per square yard of surface, as directed by the OWNER. All contact surfaces of curbs and structures and all joints shall be painted with a thin uniform coat of the asphaltic material meeting the requirements for a tack coat. Where a concrete cap is placed, it shall be allowed to cure for seventy-two (72) hours; then a tack coat shall be applied.

c) Transporting of Asphaltic Concrete:
The asphaltic mixture, prepared as specified above, shall be hauled to the work site in tight vehicles previously cleaned of all foreign material. The dispatching of the vehicles shall be arranged so that all material delivered may be placed and rolling shall be completed during daylight hours. In cool weather or for long hauls, canvas covers and insulation of the truck body may be given a light coating of oil, lime slurry, or other material satisfactory to the OWNER, if necessary, to prevent mixture from adhering to the body. The material shall be loaded in such a manner as to prevent segregation.

d) Placing:
The surface coat shall be placed in two inch (2") horizontal layers and shall be compacted to ninety percent (90%) of the theoretical density. The mixture shall be laid only on an approved base course or pavement which has been tack-coated as previously specified and shall be free of all foreign materials. All contact surfaces of curbs and structures and all

joints shall be painted with a thin, uniform coating of cut-back or emulsified asphalt as required for tack coating the base. The mixture shall be thoroughly aerated and then spread into place in a uniform layer of such depth that after compaction is complete, the requirements of the typical cross-sections will have been fulfilled. Hand spreading will be permitted where the mixture is placed on narrow strips or small irregular areas. During the application of asphaltic material, care shall be taken to prevent splattering of adjacent pavement, curb and gutter, and structures.

Where more than one course of pavement is to be placed and the material is to be laid cold, no succeeding course shall be placed until the preceding course has been in place for a sufficient period of time for the preceding course to dry and cure out. The drying and curing period shall be not less than forty-five (45) days, in any case, unless a variation is authorized in writing by the OWNER.

e) Compacting:
The pavement shall be compacted thoroughly and uniformly with the necessary rollers to obtain the density, stability, and cross-section of the finished paving mixture meeting the requirements of the Plans and Technical Specifications and the approval of the OWNER.

For mixtures being placed cold, rolling patterns will be established at the beginning of the placement with the equipment necessary to give a uniform density, stability, and cross-section of the finished paving mixture meeting the requirements of the Plans and specifications and the approval of the OWNER. This pattern will be followed until such time as it is determined by the OWNER that it is no longer giving a satisfactory pavement. At such time, the paving operation will stop until necessary corrective measures can be accomplished that meet the approval of the OWNER.

f) Substitutions:
Limestone Rock Asphalt Pavement (LRA) as specified per TXDOT Item 330 is an approved substitution for Method B – Hot Mix-Cold Laid Asphaltic Concrete.

4.7.5 Measurement and Payment

All work and material furnished under this section will be paid consistent with progress of the work at the unit price per the Bid Form for Asphalt Pavement Repair for the actual quantity of units installed as measured by the linear footage along the centerline of the trench within existing asphalt pavement multiplied by the trench width indicated on the Plans.

4.8 – Barricading Standards and Procedures

4.8.0 General

4.8.0.1 Scope

It shall be the responsibility of the Contractor to provide, erect, place, and maintain all warning signs, traffic control devices, and barricades. All such signs, devices, and barricades shall conform to standards set forth in the Texas Manual on Uniform Traffic Control Devices. The Owner may authorize the use of different or special devices and equipment, if in its opinion, such equipment will be at least as effective for its intended purposes as that set forth above and when additional regulatory signs are deemed necessary by the Owner. The Contractor shall be responsible for providing barricading for all work areas during the construction of this project.

4.8.1 Barricading Plan

CONTRACTOR shall prepare and submit a traffic control plan (TCP) for each phase of construction. The TCP shall be overlaid on the construction plans, an aerial image or other suitable media, prepared and certified by a Professional Engineer, registered in the State of Texas, and show all necessary barricades, signs, etc., required to provide a safe work site. Plans shall be based on the recommendations in the Manual of Uniform Traffic Control Devices for control of traffic in a construction area. Plans shall be submitted and method of re-routing will be approved by the OWNER. Approval will be for routing and for length of time of barricading only.

The CONTRACTOR shall conduct his work to interfere as little as possible with public travel, both vehicular and 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.

4.8.2 Maintenance

It shall be the total responsibility of Contractor to maintain the barricades, lights, signs, and all other items involved in the detouring of traffic. Contractor shall designate an employee who will be responsible for the maintenance of the barricades and lighting system on a 24-hour basis, and shall provide a phone number where the responsible party can be reached on a 24-hour basis.

4.8.3 Measurement and Payment

All work and material furnished under this section will be paid consistent with progress of the Work at the lump sum price per the Bid Form for Traffic Control Measures.

4.10 - Valves and Valve Installation

4.10.0 General

4.10.1 Section Includes

a) Resilient Seat Gate Valves
b) Swing Check Valves
c) Combination 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. 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. All valves shall be furnished with the necessary bolts, nuts, glands, gaskets, and other accessories necessary for their complete installation.

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 adjustable valve stand.

All nuts, bolts, washers, etc. shall be 316 stainless steel.

4.10.3 Resilient Seat Gate Valves

Gate valves shall be suitable for raw wastewater use. Buried gate valves shall be flanged, non-rising stem resilient seat gate valves with 2-inch square operating nut and valve box. Gate valves within vaults shall be flanged, rising stem resilient seat gate valves with hand wheel.

Gate valves shall conform to AWWA C509 and be manufactured by American Darling, EJIW, J&S, Mueller, M & H or U.S. Pipe, or OWNER approved equal.

Gate valves shall be solid wedge, resilient-seat 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.

4.10.4 Swing Check Valves

Check valves shall be suitable for raw wastewater use. Check valves shall be flanged and configured with surge protection and a mechanical disc position indicator.

Check valves shall conform to AWWA C508 and be manufactured by Val-Matic Surgebuster or OWNER approved equal.

Swing Check valves shall be full body flange type swing check valve with full size domed access cover and 100% unrestricted flow area suitable for operation up to 150 pounds per square inch pressure.

4.10.5 Combination Air Release Valves

Air release valves shall be combination air-vacuum release valves (CAV) suitable for raw wastewater use. CAVs shall be flanged, single body, capable of allowing large volumes of air to vent or enter the pipeline while allowing small volumes of air to escape the pipeline during operation. CAVs shall remain watertight during operation.

Combination air-vacuum release valves shall conform to AWWA C512 and be manufactured by A.R.I. Model D-025 (short) or OWNER approved equal.

Combination air-vacuum release valve body and components shall be manufactured from corrosion-resistant materials.

4.10.6 Ball Valves

Valves smaller than two inches (2") shall be brass ball valves as manufactured by Mueller or James Jones.

4.10.7 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: 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.

4.10.8 Valve Operations

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

4.10.8.1 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").

Wrench nuts shall be standard AWWA 2-inch square.

4.10.9 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.

4.10.10 Drawings and Data

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

4.10.11 Installation

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.

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

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

4.11 - Pressure Pipe Testing

4.11.0 General

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. 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 ten (10) gal./inch dia./mile/day.

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 Measurement and Payment

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

4.14 – Water Service Lines

4.14.0 General

4.14.0.1 Scope

This section covers the furnishing and installation of water service lines. The plans show the sizes and general arrangement of all service lines and fittings, however, the responsibility for furnishing exact lengths of the various lines for proper "make-up" rests with the CONTRACTOR. The CONTRACTOR shall provide all materials, fittings, equipment and resources required for complete installation.

4.14.1 Materials

All one inch (1") service lines will be Type K copper tubing up to the meter.

Service lines beyond the meter shall be Schedule 40 PVC in sizes shown on the Drawings.

PEX-A water service piping with compression fittings may be used with approval by the OWNER.

4.14.2 Installation

It is intended that the line be laid to such a depth that there will be a minimum cover of thirty inches (30"). Where a line passes under the curb, the line shall be at least thirty inches (30") below the bottom of the curb. Proposed water meters shall be placed within three feet (3') of the curb; The CONTRACTOR shall retain a Licensed Plumber for work on services on the customer side of the meter where applicable and shall obtain all permits and observe all plumbing code requirements of the City of San Angelo.

4.14.4 Measurement and Payment

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

4.15 - Highway, Creek, and River Crossings

4.15.0 General

4.15.0.1 Scope

This specification shall govern for the construction of water or sanitary sewer mains on or across streets, alleys, highways, creeks, or river crossings as detailed in the plans. The CONTRACTOR shall provide and employ adequate warning signs, barricades, light, watchmen, etc., to fully protect his workers and the traveling public. No changes shall be made in location as shown on the plans without prior authorization of the appropriate agency and the OWNER.

All crossings shall comply fully with the Plans and Technical Specifications, OWNER's direction, and the requirements of the agency of authority. If boring or tunneling is indicated or specified, the work shall be performed in accordance with the Highway/Railway Boring of Tunneling specification section of this document.

4.15.0.2 Blasting

Blasting will not be allowed without prior authorization of the appropriate agency and the OWNER.

4.15.1 State Highway Crossings

4.15.1.1 State Requirements

All highway crossings shall conform to the Texas State Department of Highways and Public Transportation Utility Accommodation Policy Manual Special Specifications and the following requirements.

4.15.1.2 Backfill

All Excavations within the right-of-way and not under surfacing shall be backfilled by compacting six inch (6″) horizontal layers. All surplus material shall be removed from the right-of-way, and the excavation finish shall be flush with the surrounding natural ground.

4.15.1.3 Re-vegetation Requirements

Where sodding is disturbed by excavation or backfilling operations, such areas shall be reseeded. Re-vegetation will be performed in compliance with Texas Department of Transportation Standard Specifications for Construction and Maintenance of Highway, Streets and Bridges (latest version).

4.15.1.4 Encasement Pipe

The diameter of encasement pipe shall be as shown on the plans. Encasement pipes shall be seamless or welded carbon steel. The CONTRACTOR is responsible for determining the thickness required for each bore. Steel casing shall be designed to support the load of the highway and all other superimposed loads, including loads placed on the casing during installation. Minimum thickness required for all pipe diameters is 1/4 inch. Regardless of the method used in installing the encasement pipe, it shall be installed with even bearing throughout its length and all voids between the pipe and the earth or rock shall be filled with grout.

4.15.1.5 Method of installation

The pipe shall be installed by boring or tunneling in full conformance with the Highway/Railway Boring or Tunneling Specifications section of this document. The pipe shall be installed with even bearing throughout its entire length, and all voids between the pipe and the earth or rock shall be grouted per ASTM C476.

4.15.2 River Crossings

River crossings, siphons, and miscellaneous pipe structures shall be constructed according to the detail drawings. Any proposed alternate method of installation shall be submitted and approved by the OWNER.

CONTRACTOR shall provide and maintain all necessary coffer dams, pumps, sand-bags, and other temporary controls necessary to complete River Crossings as shown on the Drawings.

CONTRACTOR shall coordinate with OWNER and other regulatory agencies and comply with environmental, biological, and historical preservations identified for completion of the Work as shown on the Drawings.

4.15.3 Measurement and Payment

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

Base Bid is established as crossing of the North Concho River by weighted and anchored piping laid along the bottom of the river channel as shown on the Drawings. All costs associated with this installation method shall be considered incidental and subsidiary to the established unit bid items.

Alternate Bid #1 is established as crossing of the North Concho River by excavating and burying piping along the bottom of the river channel as shown on the Drawings. All costs associated with this installation method, including deductive costs for items not installed (ie. weighted anchors), must be reflected in the Lump Sum price for Alternate Bid #1. This item will only be paid if the installation method is selected by 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 and in accordance with the American Concrete Institute (ACI) 318.

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.

l) **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^2 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 (in.)	Course Aggregate Size (lbs. Cement per Cubic Yd.)		
	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
½	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 pre-stressed 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 ¾-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:

Outdoor Temperature	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 (32º F) or lower. Do not place concrete when the ambient temperature in the shade is below forty degrees (40º F) and falling unless approved. Concrete may be placed when the ambient temperature in the shade is thirty-five (35º F) and rising or above forty degrees (40º 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 (32º 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^3) 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^3) 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 ¼-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 ¼-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.

4.16.38 Measurement and Payment

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

4.23 – Polyvinyl Chloride (PVC) Gravity Sewer Pipe

4.23.0 General

4.23.0.1 Scope

This section covers the furnishing and installation of PVC gravity sewer pipe. The plans show the sizes and general arrangement of all pipes; however, the responsibility for furnishing exact lengths of the various pipes for proper "make-up" and for providing special items as may be required to simplify or facilitate the installation rests with the CONTRACTOR.

4.23.1 Material Specifications

PVC Gravity Pipe shall conform to the latest revision of ASTM D3034 SDR 35 for 4 through 15 inches diameter and latest revision of ASTM F679 PS 46 for diameters greater than 15 inches in diameter. Pipe shall be SDR 26 if the pipe has less than 30 inches, more than 15 feet of cover at finished grade, or as indicated on the plans.

Joints shall be integral wall bell and spigot which complies with all the requirements of the latest revision of ASTM D3212. The rubber gasket shall meet the requirements of the latest revision of ASTM F477 for elastomeric seals. Pipe and fittings shall be assembled with a non-toxic vegetable soap lubricant which also meets the pipe manufacturer's specifications. Each length of pipe shall be clearly marked with the manufacturer's trade name, the size and class, and the specifications that it meets.

4.23.2 General Installation

PVC pipe, fittings and specials are to be installed at locations shown on plans. The trench bottom should be smooth and free from stones greater than 1/2" diameter and large dirt clods.

All pipe, fittings, and specials shall be lowered into the trench by some suitable means, and shall not be rolled or dumped into trench. All dirt or trash shall be removed from the ends of the pipe. Any damaged, defective or unsound material shall be suitably repaired or replaced before use. 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 as suggested by the manufacturer. The pipe is to be kept clean during the laying operation and free of all sticks, dirt and trash, and at the close of each operating day, the open end of the pipe is to be effectively sealed against the entrance of all obstructions and especially water. Any pipe that becomes contaminated before or after installation shall be removed and replaced unless a method to clean the pipe is approved by the OWNER.

4.23.3 Embedment and Bedding Material

The embedment zone for PVC gravity sewer pipe shall be Type II for installation with a minimum of 30 inches of cover at finished grade unless otherwise noted in the plans and/or specifications. Piping with less than 30 inches of cover at finished grade shall have Type V embedment unless otherwise noted in the plans and/or specifications (unless a concrete cap is provided).

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. Bedding shall comply with these Specifications.

4.23.4 Cutting and Beveling

When necessary, PVC pipe may be cut to properly locate appurtenances. Pipe may be cut with a fine toothed hacksaw, handsaw or portable skill-saw with a steel blade or abrasive discs. The pipe shall be marked around its entire circumference prior to cutting to assure a square cut. After the pipe is cut, the cut end shall be beveled. A factory beveled-end guide shall be used to determine the angle and length of the taper. The end may be beveled using a pilot plastic pipe beveling tool, coarse file, rasp or abrasive disc.

4.23.5 Joint and Pipe Testing

See Section "Sewer Line Testing".

4.23.6 Connections with Existing Facilities

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 service to customers affected thereby, and as authorized by the OWNER. Facilities shall be provided for proper dewatering and for disposal of all water removed from the dewatered lines and excavations without damage to adjacent property.

4.23.7 Measurement and Payment

All work and material furnished under this section will be paid consistent with progress of the Work at the unit price per the Bid Form for Gravity Sewer Main for the actual quantity of units installed as measured by the linear footage along the centerline of the trench.

4.25 – Closed Bottom Fiberglass Manhole – Type A

4.25.0 General

Fiberglass reinforced polyester manhole shall be manufactured from commercial grade polyester resin or other suitable polyester or vinyl ester resins with fiberglass reinforcements. Manhole shall be a one piece unit manufactured to meet or exceed all specifications of A.S.T.M. D-3753 latest edition as manufactured by L.F. Manufacturing, Inc., Giddings, Texas, 1-800-237-5791 or an approved equal.

4.25.1 Materials

a) **Resin**: The resins used shall be a commercial grade unsaturated polyester resin or other suitable polyester or vinyl ester resin.

b) **Reinforcing Materials**: The reinforcing materials shall be commercial Grade "E" type glass in the form of continuous roving and chop roving, having a coupling agent that will provide a suitable bond between the glass reinforcement and the resin.

c) **Interior Surfacing Material**: The inner surface exposed to the chemical environment shall be a resin-rich layer of 0.010 to 0.020 inch thick. The inner surface layer exposed to the corrosive environment shall be followed with a minimum of two passes of chopped roving of minimum length 0.5 inch (13 mm) to maximum length of 2.0 inch (50.8 mm) and shall be applied uniformly to an equivalent weight of 3 oz/ft. Each pass of chopped roving shall be well rolled prior to the application of additional reinforcement. The combined thickness of the inner surface and interior layer shall not be less than o.10 inch (2.5 mm).

d) **Fillers and Additives**: Fillers, when used, shall be inert to the environment and manhole construction. Sand shall not be accepted as an approved filler. Additives, such as thixotropic agents, catalysts, promoters, etc., may be added as required by the specific manufacturing process to be used to meet the requirements of the A.S.T.M D-3753 standard. The resulting reinforced-plastic material must meet the requirements of this specification.

e) **Wall Construction Procedure**: After the inner layer has been applied the manhole wall shall be constructed with chop and continuous strand filament wound manufacturing process, which insures continuous reinforcement and uniform strength and composition. The cone section, if produced separately, shall be affixed to the barrel section at the factory with resin-glass reinforced joint resulting in a one-piece unit. Seams shall be fiberglassed on the inside and the outside using the same glass-resin jointing procedure. Field joints shall not be acceptable.

f) **Exterior Surface**: For a UV inhibitor the resin on the exterior surface of the manhole shall have gray pigment added to a minimum thickness .125 inches.

g) **Stub-outs and Connections**: Manholes shall be provided with couplings or stub-outs cast into the manhole body by the manhole manufacturer. The couplings and stub-outs shall be provided by the same pipe manufacture used to provide pipe in the project. All pipe specifications related to couplings and connections shall apply.

h) **Manhole Bottom**: Fiberglass manholes will be required to have resin fiber-reinforced bottom. Deeper manholes may require a minimum of two fiberglass channel stiffening supports. All fiberglass manholes manufactured with a fiberglass bottom

will have a minimum 3-inch wide anti-flotation ring. The manhole bottom shall be a minimum of ½ inch thick. Manholes shall be manufactured such that concrete is not required on the inside of the manhole. Manholes shall have a factory installed integral fiberglass bench and invert area.

i) **Fiberglass Enclosed Invert and Bench Area**: A fiberglass enclosed invert and bench area shall be installed in the manhole by the manufacturer. The invert will be formed using a non-corrosive material and completely enclosed in a minimum 1/4-inch layer of fiberglass chop.

j) **Height Adjustment**: Fiberglass manholes must have the ability to be height adjustable with the use of a height adjustment ring. Height adjustment can be made as a field operation without the use of uncured resins or fiberglass lay-ups. Fiberglass manholes must maintain all load and soundness characteristics required by A.S.T.M. D3753 after height adjustment has occurred.

4.25.2 Manufacture

Manhole cylinders, manway reducers, and connectors shall be produced from fiberglass-reinforced polyester resin using a combination of chop and continuous filament wound process.

Interior Access: All manholes shall be designed so that a ladder or step system can be supported by the installed manhole.

Manway Reducer: Manway reducers will be concentric with respect to the larger portion of the manhole diameters through 60 inches. Larger manholes may have concentric or eccentric manway reducer openings.

Cover and Ring Support: The manhole shall provide an area from which a grade ring or brick can be installed to accept a typical metal ring and cover and have the strength to support a traffic load without damage to the manhole.

4.25.3 Requirements

Exterior Surface: The exterior surface shall be relatively smooth with no sharp projections. Handwork finish is acceptable if enough resin is present to eliminate fiber show. The exterior surface shall be free of blisters larger than 0.5 inch in diameter, de-lamination or fiber show.

Interior Surface: The interior surface shall be resin rich with no exposed fibers. The surface shall be free of crazing, de-lamination, blisters larger than 0.5 inch in diameter, and wrinkles of 0.125 inch or greater in depth. Surface pits shall be permitted if they are less than 0.75 inch in diameter and less than 0.0625 inch deep. Voids that cannot be broken with finger pressure and are entirely below the resin surface shall be permitted if they are less than 0.5 inch in diameter and less than 0.0625 inch thick.

Wall Thickness: Fiberglass manholes 48" in diameter and up to 20 feet in depth will have a minimum wall thickness of .3125 inches. Fiberglass manholes 48" in diameter and 20 feet to 30 feet in depth will have a minimum wall thickness of .5 inches.

Repairs: Any manhole repairs are subject to meet all requirements of this specification.

Manhole Length: Manhole lengths shall be in 6-inch increments +/- 2 inches.

Diameter Tolerance: Tolerance of inside diameter shall be +/- 1% of required manhole diameter.

Load Rating: The complete manhole shall have a minimum dynamic-load rating of 16,000 lbs. when tested in accordance with A.S.T.M. 3753 8.4 (note 1). To establish this rating the complete manhole shall not leak, crack, or suffer other damage when load tested to 40,000 lbs. and shall not deflect vertically downward more than 0.25 inch at the point of load application when loaded to 24,000 lbs.

Stiffness: The manhole cylinder shall have the minimum pipe-stiffness values shown in the table below when tested in accordance with A.S.T.M. 3753 8.5 (note 1).

LENGTH - FT.	**F/AY - PSI**
3 - 6.5	0.75
7 - 12.5	1.26
13 - 20.5	2.01
21 - 25.5	3.02
26 - 35	5.24

Soundness: In order to determine soundness, the manufacturer shall apply an air or water pressure test to the manhole test sample. Test pressure shall not be less than 3 psig or greater than 5 psig. While holding at the established pressure, inspect the entire manhole for leaks. Any leakage through the laminate is cause for failure of the test. Refer to A.S.T.M. 3753 8.6.

Chemical Resistance: The fiberglass manhole and all related components shall be fabricated from corrosion proof material suitable for atmospheres containing hydrogen sulfide and dilute sulfuric acid as well as other gases associated with the wastewater collection system.

4.25.4 Physical Properties

Property (PSI)	**Hoop Direction**	**Axial Direction**
Tensile Strength	18,000	5,000
Tensile Modules	0.6×10^6	0.7×10^6
Flexural Strength	26,000	4,500
Flexural Modules	1.4×10^6	0.7×10^6
Compressive	18,000	10,000

4.25.5 Test Methods

All tests shall be performed as specified in A.S.T.M. 3753 latest edition, section 8. Test method D-790 (see note 5) and test method D-695.

4.25.6 Quality Control

Each completed manhole shall be examined by the manufacturer for dimensional requirements, hardness, and workmanship. All required A.S.T.M. 3753 testing shall be completed and records of all testing shall be kept and copies of test records shall be presented to customer upon formal written request within a reasonable time period.

4.25.7 Certifications

As a basis of acceptance the manufacturer shall provide an independent certification which consists of a copy of the manufacturer's test report and accompanied by a copy of the test results stating the manhole has been sampled, tested, and inspected in accordance with the provisions of this specification and meets all requirements.

4.25.8 Shipping and Handling

Do not drop or impact the fiberglass manhole. Fiberglass manhole may be lifted by inserting a 4"x4"x30" timber into the top of manhole with cable attached or by a sling or "choker" connection around the center of manhole, lift as required. Use of chains or cables in contact with the manhole surface is prohibited.

4.25.9 Installation

CLOSED BOTTOM MANHOLE INSTALLATION

Bottom of excavation should be compacted to 95% Standard Proctor Density. Manholes shall have a poured reinforced concrete base at least one foot deep and at least two feet larger than fiberglass manhole outside diameter. The fiberglass manhole shall be lowered into the wet concrete and brought to plumb. Pour reinforced concrete over the anti-flotation flange.

Manholes shall be manufactured such that concrete is not required on the inside of the manhole. Manholes shall have a factory installed integral fiberglass bench and invert area.

4.25.10 Backfill

Material used for backfill around the manhole for a minimum distance of one foot from the outside surface and extending from the bottom of the excavation to the top of the reducer section shall consist of sand or stabilized soil.

Backfill shall be placed in layers of not more than 12 loose measure inches and mechanically tamped to 95% Standard Proctor Density, unless otherwise approved by the engineer. Flooding will not be permitted. Backfill shall be placed in such a manner as to prevent any wedging action against the fiberglass manhole structure.

4.25.11 Marking and Identification

Each manhole shall be marked on the inside and outside with the following information:

a) Manufacturer's name or trademark
b) Manufacturer's factory location
c) Manufacturer's serial number
d) Total manhole depth.

4.25.12 Measurement and Payment

All work and material furnished under this section will be paid consistent with progress of the Work at the unit price per the Bid Form for FRP Manhole for the actual quantity and depth of units installed as measured from the manhole rim elevation to the manhole invert elevation per each. Connections with drop or other specialized configurations shall be considered subsidiary to established manhole unit bid items.

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, with bid package, 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 ½ 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 ½ 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 ½ 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)	Hoop Direction	Axial Direction
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.

4.26.6.2 Placement

Test shall be conducted according to the Technical Standard for Testing Sanitary Sewer Systems in these specifications.

4.26.7 Measurement and Payment

All work and material furnished under this section will be paid consistent with progress of the Work at the unit price per the Bid Form for FRP Manhole for the actual quantity and depth of units installed as measured from the manhole rim elevation to the manhole invert elevation per each. Connections with drop or other specialized configurations shall be considered subsidiary to established manhole unit bid items.

4.27 – Sewer Service

4.27.0 General

4.27.0.1 Scope

This section covers material and installation requirements for sewer service line pipe and appurtenances. A sewer service is a branch sanitary sewer line constructed from the main sanitary sewer line to a point described in the plans or as established by the Owner, for the purpose of serving a specific building or buildings.

4.27.1 Material

4.27.1.1 General

Approved pipe and fitting material for sewer service shall be polyvinyl chloride (PVC). All materials shall conform to these specifications.

4.27.1.2 Polyvinyl Chloride (PVC) Pipe

Pipe shall be Schedule 40 Poly Vinyl Chloride (PVC) with tapered socket type joints and shall conform to the latest revision of ASTM D2466 - 78. Joints shall be glued with a medium bodied solvent cement having a minimum viscosity of 500 cP or as recommended by the pipe manufacturer. Solvent cement shall conform to the latest revision of ASTM 2564 - 80.

4.27.2 Installation

4.27.2.1 Placing and Laying

The service lines shall be placed where shown on the plans or as directed by the Owner. The lines shall be extended from the collection main to a distance of two (2) feet within the property line of the location to be served and plugged until placed in service. Sewer lines shall be installed at a uniform slope of not less than 1/8 inch per foot toward the point of disposal. Placement shall meet the requirements for construction of similar materials as directed in these specifications.

Cleanouts shall be placed at connection to existing sewer service lines and any deflection of alignment.

4.27.3 Testing

Sewer service lines shall be tested by capping the ends of the service and testing the entire main line following the procedure in the "Sewer Line Testing" section of these contract documents.

4.27.4 Measurement and Payment

All work and material furnished under this section will be paid consistent with progress of the Work at the unit price per the Bid Form for Sewer Service for the actual quantity of units installed as measured per each and/or by the linear footage along the centerline of the trench.

4.28 – Sewer Line and Manhole Testing

4.28.0 General

4.28.0.1 Scope

This Section will outline required testing for acceptance of construction of gravity flow 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 gravity 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 (linear ft.)	Time for Longer 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 Depth (ft.)	Manhole Diameter (in.)				
	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:

a) Plug the sewer(s) entering and leaving the manhole.

b) Fill the manhole with water to the level directed by the OWNER.

c) Let the water stand in the manhole for a minimum duration of four (4) hours.

d) Refill the manhole to the beginning level.

e) 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:

a) Plug the lower end of the section of line to be tested.

b) 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.

c) Let the water stand in the pipe and manhole for a minimum of four (4) hours.

d) After the water has stood for a minimum of four hours, refill the manhole to the original depth.

e) 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:

a) 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.

b) 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.

c) 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.

d) 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 are considered subsidiary to the various unit pay items; therefore, no additional payment shall be made for material furnished or work done under this section unless specified.

4.29 – Temporary Bypass Pumping Systems

4.29.0 General

4.29.0.1 Scope

a) Under this item, the CONTRACTOR is required to furnish all materials, labor, equipment, power and maintenance, etc. to implement a temporary pumping system for the purpose of diverting existing wastewater flows around the work area for the duration that the work requires.

b) The design, installation, and operation of the temporary pumping system shall be the CONTRACTOR's responsibility. The CONTRACTOR shall employ the services of a "Bypass Sub-Contractor" who can demonstrate to the OWNER that they specializes in the design and operation of temporary bypass pumping systems. The bypass system shall meet the requirements of all codes and regulatory agencies having jurisdiction. Bypass Sub-Contractor's shall be pre-qualified by the OWNER prior to the submission of bid. Approved Bypass Sub-Contractors are:

- Godwin Pumps, 7096 Hwy 86 East, China Grove, TX 78263; 210-648-9101
- Global Pump, 10126 E. Coldwater Rd., Davison, MI 48423; 817-919-8997 or 866-360-7867
- Griffin Dewatering, 5306 Clinton Drive, Houston, TX 77020; Phone 713-676-8000, Fax 713-676-8080
- Sunbelt Rentals Pump & Power Services, 711 N Beach Street, Fort Worth, TX 76111; Phone: 817-759-0413, Fax: 817-834-0524
- Maverick Pump Services, 9791 Titan Park Circle, Littleton, CO 80125; 303-906-4202 or 817-919-8997
- Gajeske, Inc., 200 Preston Rd., Celina, TX 75009; 817-505-9453
- Or OWNER Approved Equal

Requests to approve additional "Bypass Sub-Contractors" shall be submitted in writing to the OWNER at least seven days prior to the bid opening date. The request shall include the company's experience, references, list of similar projects, a list of equipment available and a description of the equipment and methods employed. The "Bypass Sub-Contractor" shall provide at least five (5) references of projects of a similar size and complexity as this project performed by his firm within the past three years.

4.29.1 Requirements for Submitting Pumping Proposals

a) The CONTRACTOR shall submit to the OWNER detailed plans and descriptions outlining all provisions and precautions to be taken by the CONTRACTOR regarding handling of existing wastewater flows. The Plan shall be prepared by the "Bypass Sub-Contractor". The Plan shall bear the signature demonstrating agreement and full

understanding of the CONTRACTOR and the "Bypass Sub-Contractor". This Plan must be specific and complete, including such items as schedules, locations, elevations, capacities of equipment, materials, and all other incidental items necessary and/or required to ensure proper protection of the facilities, including protection of the access and bypass pumping locations from damage due to the discharge flows, and compliance with the requirements and permit conditions specified in these Contract documents. No construction shall begin until all provisions and requirements have been reviewed by the OWNER.

b) The Plan shall include but not be limited to the details of the following:

1. Staging areas for pumps
2. Sewer plugging method and types of plugs
3. Size and location of manholes or access points for suction and discharge hose or piping
4. Size of pipeline or conveyance system to be bypassed
5. Size and location of service lines affected by bypass
6. Method of bypassing and/or maintaining service to all wastewater customers
7. Number, size, material, location and method of installation of suction piping
8. Number, size, material, method of installation and location of installation of discharge piping
9. Bypass pump sizes, capacity, number of each size to be on site and power requirements
10. Calculations of static lift, friction losses, and flow velocity (pump curves showing pump operating range shall be submitted)
11. Standby power generator size, location
12. Downstream discharge plan
13. Method of protecting discharge manholes or structures from erosion and damage
14. Method of mitigating nuisance odors generated during bypass pumping operations.
15. Thrust and restraint block sizes and locations
16. Sections showing suction and discharge pipe depth, embedment, select fill and special backfill
17. Method of noise control for each pump and/or generator
18. Any temporary pipe supports and anchoring requirements
19. Design plans and computation for access to bypass pumping locations indicated on the drawings
20. Calculations for selection of bypass pumping pipe size
21. Schedule for installation of and maintenance of bypass pumping line.
22. Plan indicating selection of location of bypass pumping line locations
23. Control plan demonstrating the instrumentation, equipment, alarms, operations procedures, emergency procedures, reset procedures, and system wiring schematics.
24. All pump, suction line and discharge line sizing calculations shall be sealed by a registered Professional Engineer licensed in the State of Texas.

4.29.2 Equipment

a) All pumps used shall be fully automatic self-priming units that do not require the use of foot-valves in the priming system. The pumps may be gas or diesel powered. All pumps used must be constructed to allow dry running for long periods of time to accommodate the cyclical nature of effluent flows. Each pump shall have an isolation valve for maintenance and pump removal. Discharge piping system or

header shall be designed to allow pumping operations to continue unabated in the event of pump maintenance or change out. In triple redundant pumping systems, at least one pump shall have an independent suction line. If a common suction header is utilized for the two remaining pumps then sufficient valves shall be installed to allow each pump to be removed from the system without interrupting the system operation.

b) The "Bypass Sub-Contractor" shall provide the necessary stop/start controls for each pump. Controls for back-up and stand-by pumps shall be fully automatic. Operation of back-up or high flow pumps shall be based on water level inside the pumping point. **The CONTRACTOR shall continuously monitor flow and adjust pumps to meet flow requirements.** All employees utilized for flow monitoring shall be trained by the "Bypass Sub-Contractor" and shall be supplied with a cell phone to ensure time frames stipulated in Section 3.29.4 D.2 are met.

c) The CONTRACTOR shall provide primary, backup and standby pumps. Backup and standby pumps shall be online, with automatic controls.

d) Pump and air relief valves shall be provided with spill protection & control devices designed to capture and contain any fuel or sewage that may spill during the normal course of operation.

e) Discharge Piping – In order to prevent the accidental spillage of flows, all discharge systems shall be constructed of HDPE pipe with fused joints. Under no circumstances will "irrigation" type piping or glued PVC pipe be allowed. Discharge piping shall be pressure rated for a minimum of 150% of maximum head of the pumping system.

f) Noise Control – All pumping equipment, including back-up and high flow pumps shall be sound attenuated. The measured sound level at thirty feet from the pumping unit shall be 70 dBA or less.

g) The CONTRACTOR and / or Bypass Sub-Contractor shall provide any suction vaults, manholes or other appurtenances required for a fully functional suction system. These systems shall be fully contained and shall not allow for leakage or discharge outside of the containment area. All costs associated shall be included in the Contract Bid.

4.29.3 Design

a) Design Requirements

1. Trunk Bypass pumping systems shall have sufficient capacity to pump the flows indicated on the project drawings.

2. The "Bypass Sub-Contractor" shall provide to the CONTRACTOR all pipeline plugs, pumps of adequate size to handle peak flow, and temporary discharge piping to ensure that the total flow of the main can be safely diverted around the section to be repaired. Bypass pumping systems will be required to be operated 24 hours per day.

b) Performance Requirements

1. It is essential to the operation of the existing system being bypassed that no interruptions in the flow occur throughout the duration of the project. To this end, the CONTRACTOR shall provide, maintain, and operate all temporary facilities such as dams, plugs, pumping equipment (both primary and back-up units are required), conduits, all necessary power, and all other labor and equipment necessary to intercept the incoming flow before it reaches the point where it would interfere with his work, carry it past the work area and return it to the existing system downstream of his work.

2. The design, installation and operation of the temporary pumping system shall be the CONTRACTOR's responsibility. The bypass system shall meet the requirements of all codes and regulatory agencies having jurisdiction.

3. The CONTRACTOR shall provide all necessary means to safely convey the sewage past the work area. The CONTRACTOR will not be permitted to stop or impede the main flows under any circumstances.

4. The CONTRACTOR shall divert the flow around the work area in a manner that will not cause damage to, or surcharging of customer's system and will protect public and private property from damage and flooding.

5. The CONTRACTOR shall incorporate odor control measures into the temporary bypass pumping system.

6. The CONTRACTOR shall protect water resources, wetlands, and other natural resources.

4.29.4 Field Quality Control and Maintenance

a) Test:

1. The CONTRACTOR shall perform leakage and pressure tests of the bypass pumping discharge piping using clean water prior to the actual operation. The OWNER will be given 24 hours notice prior to testing. Piping shall be tested to minimum of 150% of maximum design head of the pumping system.

b) Inspection:

1. The CONTRACTOR shall monitor and operate the bypass pumping systems on a continuous basis to ensure the system is working correctly.

c) Maintenance Service:

1. The CONTRACTOR shall ensure the pumping system is properly maintained and a responsible operator shall be on hand at all times when pumps are operating.

2. The CONTRACTOR shall monitor pump fuel levels and make arrangements for timely refueling as needed.

d) Extra Materials:

1. Spare parts for pumps (minimum of air and fuel filters) and piping shall be kept on site as required for continuous operation. "Bypass Sub-Contractor" shall provide a contact that is continually available (24 hours a day). "Bypass Sub-Contractor" shall provide replacement units within 24 hours of notice being provided.

2. Adequate hoisting equipment for each pump and accessories shall be maintained on the site.

4.29.5 Preparation

a) Precautions

1. CONTRACTOR is responsible for locating any existing utilities in the area selected for the bypass pipelines. The CONTRACTOR shall locate the bypass pipelines to minimize any disturbance to existing utilities and shall obtain approval of the pipeline locations from the customer. All costs associated with relocating utilities and obtaining all approvals shall be paid by the CONTRACTOR.

2. During all bypass pumping operations, the CONTRACTOR shall protect the OWNER's system (Pumping Station, Conveyance System, etc.) as applicable from damage inflicted by any equipment. The CONTRACTOR shall be responsible for all physical damage to the OWNER's system caused by human or mechanical failure.

4.29.6 Installation and Removal

a) The CONTRACTOR shall remove manhole sections or make connections to the existing conveyance system and construct temporary bypass pumping structures only at the access location indicated on the Drawings and as may be required to provide adequate suction conduit.

b) Plugging or blocking of flows shall incorporate a primary or secondary plugging device. When plugging or blocking is no longer needed for performance and acceptance or work, it is to be removed in a manner that permits the sewage flow to slowly return to normal without surge, to prevent surcharging or causing other major disturbances downstream.

c) When working inside manhole or force main, the CONTRACTOR shall exercise caution and comply with OSHA requirements when working in the presence of sewer gases, combustible or oxygen-deficient atmospheres, and confined spaces.

d) The installation of the bypass pipelines is prohibited in all marsh/wetland areas. The pipeline must be located if possible off streets and sidewalks and on shoulders of the roads. When the bypass pipeline crosses local streets and private driveways, the CONTRACTOR must place the bypass pipelines in trenches and cover with temporary pavement or steel plates. Upon completion of the bypass pumping operations, the CONTRACTOR shall remove all the piping, restore all property to pre-construction condition, and restore all pavement. The CONTRACTOR is responsible for obtaining any approvals for placement of the temporary pipeline from the OWNER.

4.29.7 Emergency Conditions

Emergency conditions shall be declared to exist if a sufficient number of pumps in the system become inoperable to the point that the peak flow cannot be pumped. Once this condition exists, the CONTRACTOR shall immediately initiate work to allow for the return to gravity flow. Pumping operations will not be allowed to resume until the full number of primary, standby and backup pumps are returned into service. Monitoring requirements shall be same as required in Section 3.9 (7) a.

4.29.8 Project Specific Requirements

a) All Pumps (Primary, Standby and Backup) required for the Trunk Bypass Pump Set shall be commonly headered on discharge and shall either be commonly headered on suction or each have individual suction lines that are all available to pick up suction immediately on demand to pump.

Minimum total number of pumps required for each pump set location shall be as follows:

1. Sewer mains 12" in diameter and larger: Triple redundancy is required. System shall consist of a) primary pump, b) stand-by pump and c) back-up pump(s).

2. Sewer mains less than 12" in diameter: Full redundancy is required. System shall consist of a) primary pump and b) back-up pump(s)

b) Trunk Bypass Pump Set Pumps and Capacities:

1. Primary Pump Set (Critically Silenced / Sound Attenuated)

   i. Peak Pump – Capacity provided shall be at least the peak flow specified at the required system head without cavitation.

   ii. Avg. Flow Pump – Capacity provided shall be at least the average flow specified at the required system head without cavitation and shall be able to pump minimum flow specified at system head without cavitation.

2. Standby Pump Set (Critically Silenced / Sound Attenuated):

   i. Peak Pump – Capacity provided shall be at least the peak flow specified at the required system head without cavitation.

   ii. Avg. Flow Pump – Capacity provided shall be at least the average flow specified at the required system head without cavitation and shall be able to pump minimum flow specified at system head without cavitation.

3. Backup Pump Set (May be Non-Critically Silenced / Non-Sound Attenuated, Open Pumps with Mufflers):

   i. Peak Pump – Capacity provided shall be at least the peak flow specified at the required system head without cavitation.

c) Piping System:

1. Suction Piping: Shall be engineered and sized to meet the required suction heads of the pumps under maximum flow conditions.

2. Discharge Piping: Shall be engineered such that the system requirements for peak, average and minimum flows are consistent with the pump curves and specified flow requirements. The minimum pipe size shall be sized to maintain a minimum velocity of 2 fps. If multiple discharge pipe runs are utilized, at least one of the discharge line runs shall be the same size as the force main.

d) "Bypass Sub-Contractor" Representation:

1. Setup: A "Bypass Sub-Contractor" Representative qualified in operation and repair of the "Bypass Sub-Contractor's bypass pumping systems shall be on-site for a minimum 7 days of continuous system operation after start-up of each pump set-up.

2. Service Check: A "Bypass Sub-Contractor" Representative / Mechanic shall check all systems once every two (2) weeks and provide a detailed service report to the City of San Angelo Representative. Any repairs or problems shall be corrected immediately. Maximum time allowance for routine system repair is 24 hours.

3. Full Service: The "Bypass Sub-Contractor" shall provide full service for each of the pumps once (1) every two (2) months or more frequently if recommended under Manufacturer's standard operations manual.

e) Pump Tests:

1. Each pump shall be run at least once every week demonstrating that it will automatically prime and pump continuously for a minimum of thirty (30) minutes.

2. A written report detailing performance, problems, alerts, failures and repairs shall be provided to the OWNER within 24 hours of test completion.

f) System Monitoring:

1. The CONTRACTOR shall require and ensure that the Bypass Pump System is continuously manned by the CONTRACTOR during operations.

i. The individuals responsible to monitor the system shall be fully trained by the "Bypass Sub-Contractor" on the operation of the system and emergency actions and restart of the system.

ii. The individuals may be employed by either the "Bypass Sub-Contractor" or the CONTRACTOR. In either case, letters shall be provided certifying that the named individuals are employees of the either the "Bypass Sub-Contractor"–or the CONTRACTOR and are certified as competent to monitor and operate the Bypass Pump System. These letters shall be provided to the City. Any changes in personnel shall require the same documentation.

g) Pumping System Repairs:

1. Pump Failure: Should any one (1) of the Trunk Bypass Pumps fail:

i. The CONTRACTOR, "Bypass Sub-Contractor", and OWNER shall be notified immediately.

ii. The "Bypass Sub-Contractor" shall have a qualified representative and mechanic on-site within 24 hours of failure.

iii. The Trunk Bypass System shall be returned to 100% function within 72 hours of failure.

2. Multiple Pump (more than one) or System Failure:

i. The CONTRACTOR, "Bypass Sub-Contractor", and OWNER shall be notified immediately.

ii. The "Bypass Sub-Contractor" shall have a qualified representative and mechanic on-site within 6 hours of failure.

iii. The Trunk Bypass System or System Gravity Flow shall be restored to Peak Flow Capacity within 12 hours of failure.

iv. The Trunk Bypass System shall be returned to 100% function within 72 hours of failure.

h) 24 Hour Emergency Contacts:

1. Contractor:

i. The CONTRACTOR shall provide a priority 24 hour phone number to call in an emergency.

ii. The CONTRACTOR shall provide a list of three (3) Qualified Representatives for this project. These individuals shall have complete access to "Bypass Sub-Contractor's and personnel for response to any emergency. The list shall have three (3) personnel with action / decision authorization to respond. One of these individuals shall be on-site within one (1) hour of any emergency situation.

iii. This number shall be available and responsive 24 hours a day; 365 days a year.

iv. Any messages received via this line shall be responded to by a Qualified Representative of the CONTRACTOR within 30 minutes.

2. "Bypass Sub-Contractor":

i. The "Bypass Sub-Contractor" shall provide a priority 24 hour phone number to call in an emergency.

ii. The "Bypass Sub-Contractor" shall provide a list of Qualified Representatives for this project. The list shall have a minimum of three (3) personnel and a maximum of four (4).

iii. This number shall be available and responsive 24 hours a day; 365 days a year.

iv. Any messages received via this line shall be responded to by a Qualified Representative of the "Bypass Sub-Contractor" within 30 minutes.

4.29.9 Measurement and Payment

All work and material furnished under this section will be paid consistent with progress of the Work at the lump sum price per the Bid Form for Bypass Pumping.

CONTRACTOR shall be responsible for all costs incurred by the City associated with any spills (sewage and/or fuel) due to failure of the pumping system or actions of employees. CONTRACTOR shall be responsible for any fines issued by the city, state or federal agencies associated with any spills (sewage and/or fuel).

4.30 – Sanitary Sewer Main Cleaning and CCTV Camera Inspection

4.30.0 General

a) CONTRACTOR shall inspect existing wastewater mains indicated on the Plans using CCTV wastewater inspection camera equipment suitable for the size and characteristics of the main.

b) Digital video files of the existing main inspections shall be provided to the OWNER on portable USB device in a media format compatible with common media viewing software. Contractor shall provide three (3) copies of all inspection video files.

c) CONTRACTOR shall be responsible for cleaning main, bypass pumping, temporary repairs, determining low points locations, service locations, and general condition of mains identified on the Plans.

4.30.1 Measurement and Payment

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

4.33 - Furnishing and Placing Topsoil

4.33.0 Description

This Item shall govern for the furnishing and placing of approved topsoil to the depths and area shown on the plans or as directed by the OWNER.

4.33.1 Materials

Topsoil shall only be obtained from the 'A horizon' of the soil profile as defined by the U.S. Department of Agriculture Soil Survey. The topsoil shall be fertile soil, be easily cultivated, be free from objectionable material, have a relatively high erosion resistance and be readily able to support the growth of planting, seeding or sodding. Topsoil shall consist of a loam, sandy loam, clay loam, silt loam, sandy clay loam or loamy sand. Topsoil shall NOT be a mixture of contrasting textured sub-soils. It shall be free of stones, noxious weeds, grass, cinders, stones, slag, coarse fragments, gravel, sticks, roots or other materials. No trash will be acceptable in the topsoil. Any separating operations conducted by the CONTRACTOR shall be conducted at the material source pit and shall not be performed after the topsoil has been placed to merely "dress-up" the visible portion of the topsoil.

Topsoil shall contain not less than three percent (3%) or more than twenty percent (20%) organic matter, by weigh. Organic material shall be decomposed and free of wood. The Soluble Salt content of the topsoil shall not exceed 1.5 mmho/cm. Soil pH shall be between 6.1 and 7.5.

4.33.2 Sources

The topsoil source(s) shall be tested by the CONTRACTOR to ensure compliance with these specifications. Soil samples shall be obtained following the guidelines established by the Texas A&M Soil, Water and Forage Testing Laboratory. Test results (Textural Analysis, Organic Matter, Soluble Salt and pH) shall be provided to the OWNER prior to placement of topsoil.

4.33.3 Construction Methods

Topsoil shall be placed where directed by the OWNER. Any trash, wood, brush, stumps or other objectionable materials encountered at the source shall be removed and disposed of prior to final placement of the topsoil. The source and stockpile areas shall be kept drained, insofar as practicable. Prior to placement, topsoil shall contain adequate moisture to eliminate dust and to facilitate rolling.

The placement of the topsoil shall be undertaken as soon as the final backfill has been completed. Topsoil shall not be placed when the ground or topsoil is frozen, excessively wet or in any other condition that is otherwise detrimental to the work being performed. The topsoil shall be spread so as to form a cover of a minimum of six inches (6") of uniform thickness. After the topsoil has been placed and shaped, it shall be lightly rolled a light corrugated drum roller or other approved equipment. Topsoil shall not be overly compacted. The final grading of the topsoil shall be to a tolerance that will not permit ponding of water.

4.33.4 Measurement and Payment

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

4.34 – Abandonment of Sanitary Sewers

4.34.0 General

4.34.1 Description

This item shall govern the abandonment of sanitary sewer mains, services and manholes identified on the Plans to be abandoned. The sanitary sewer facility shall be abandoned in accordance with the specifications herein outlined and in conformity with the limits shown on the Plans. Abandoning of sanitary sewer lines shall not occur until all existing sanitary sewer services have been transferred to another line and directed by the OWNER.

4.34.2 Materials

A cement based grout shall be used to fill the void of the existing sanitary sewer main/services. The grouting material must have a strength of at least 1000 psi and shall have flow characteristics appropriate for filling a sanitary sewer. The grout mix designed and method of installation shall be approved by the OWNER prior to beginning operation.

4.34.3 Construction

Abandonment of sanitary sewer lines shall be accomplished by installing the grout material with sufficient pressure and in numerous locations. Placement of grout shall be limited to sections 500 feet in length or less. The method of installation shall be able to meet the requirement of completely filling the existing sanitary sewer line and any voids adjacent to the sanitary sewer line. The method shall adequately provide for the removal and legal disposal of existing sewer materials in the system. The method shall provide for the release of air. When intermediate points are required to be constructed for the abandonment of the system, repairs shall be a part of the abandonment project process.

4.34.4 Measurement and Payment

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

4.35 – Sanitary Sewer Main Installation

4.35.0 General

4.35.0.1 Scope

This section covers pipe and appurtenances required for the construction of this sewer project. The pipe, manholes, clean-outs and other appurtenances required shall be of the classification, size, types and dimensions as designated on the plans, details and profiles, or by the OWNER in accordance with these specifications, and in conformity with the lines and grades given.

The materials called for in these specifications shall be finally inspected by the OWNER or his representative immediately before being used in the construction. This inspection shall take precedence over any or all inspections of the same material that may have been previously made. The OWNER will not attempt to designate between materials rejected to factory defects and that are rejected because of transportation damage.

4.35.1 Materials

4.35.1.1 Pipe

Except as otherwise specified in the plans or specifications, sanitary sewer pipe shall be Glass Fiber Reinforced (GFR) or Polyvinyl Chloride (PVC). Joints shall be integral wall gasketed bell and spigot joints or butt fusion joints unless otherwise specified. Pipe shall conform to all material specifications, installation guidelines and drawing details. The material chosen for a site shall be used continuously throughout the location unless otherwise noted on the plans.

4.35.1.2 Detectable Marking Tape

CONTRACTOR shall install detectable marking tape with all new pipeline installations. Detectable marking tape shall be installed in the backfill zone, no closer than twelve (12) inches above the top of embedment material nor closer than twenty-four (24) inches below the top of finished grade.

Gravity Sewer Mains: Detectable marking tape on gravity sewer mains shall be minimum 5 mil thickness, 3-inch width, with the words "SANITARY SEWER" continuously repeated in at least 1.5-inch tall letters.

Force Mains: Detectable marking tape on pressurized sewer mains shall be minimum 5 mil thickness, 6-inch width, with the words "PRESSURIZED WASTEWATER" continuously repeated in at least 4.5-inch tall letters.

4.35.1.3 High-Strength Tracer Wire

CONTRACTOR shall install high-strength tracer wire secured to the top of the force main pipe. Tracer wire shall be Copperhead 1430 or OWNER approved equal.

Tracer wire shall be continuous the entire length of the pipeline, with terminations made at manholes and vaults to the satisfaction of the OWNER.

4.35.1.4 Manhole Shaft and Concentric Cone Top

The manhole shaft and concentric cone top shall be fiberglass conforming to the material specifications provided in these documents or approved by the OWNER. Concrete manholes may be used only as approved by the OWNER.

4.35.1.5 Manhole Frames, Covers, and Cleanouts

All castings of manhole frames, covers, steps and cleanouts shall be good quality gray or malleable cast iron, tough resilient, and even grain; castings shall be sound, and free from cracks, sand holes or bellow holes. The cast iron shall have a tensile strength of 18,000 pounds per square inch. All castings shall be of the design shown on the plans or provided in these specifications and are subject to approval by the OWNER.

4.35.1.6 Manhole Frames and Covers

Manhole frames and covers shall be East Jordan Iron Works V1177 (or V2432 for water tight applications) or approved equal with a minimum weight of 300 pounds. All frames and covers shall be approved by the OWNER prior to installation. Manhole covers shall provide a 30" clear opening.

4.35.1.7 Steps

No steps shall be constructed in manholes.

4.35.1.8 Cleanouts

Cleanouts shall be of the size, type and design shown on the standard detail sheet of the plans.

4.35.1.9 Concrete

Concrete shall conform to the Material Standard for Concrete in these specifications.

4.35.2 Pipe Installation

4.35.2.1 General

The CONTRACTOR shall remove as much of the street or road surfaces as may be necessary and where necessary; excavate the trenches to the required dimensions; and grade, sheet, brace and support the adjoining ground or structures where necessary; handle all drainage or ground water; guard the site; construct and maintain all bridges required for traffic control; unload, haul, distribute, construct and test all pipe and accessories; rearrange other conduits, ducts, or pipes where necessary; replace all damaged utility services, fences, utilities and other structures; backfill the trenches and pits; remove surplus excavated material; clean the site of the work, and maintain the streets or other surfaces over the trenches for the successful completion of the project.

4.35.2.2 Equipment

All equipment necessary for the construction of these sanitary sewer improvements shall be available for the project, in first-class working condition, and shall have been approved by the OWNER before construction is permitted to commence.

The CONTRACTOR shall provide hand tampers and pneumatic tampers to obtain compaction of the pipe bed and backfill as required on the plans.

4.35.2.3 Pipe Handling

All pipe and fittings 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 material or any coatings. 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. 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 watertight plug. Any pipe section that becomes contaminated shall be removed and replaced unless a method to clean the pipe is approved by the OWNER.

4.35.2.4 Stringing of Pipe

Unless prior approval from the OWNER is granted to do otherwise, stringing of pipe in advance of the laying operation shall be restricted to one week's laying and shall be done in such a manner as to create neither hazard to nor interference with traffic. Ready access shall be provided to all streets, alleys and driveways. The pipe shall be protected at all times with barricades and warning signs, as well as protecting the pipe from stormwater flows. Any damage to the pipe shall be corrected at the expense of the CONTRACTOR.

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 restricted to 75% of maximum deflection limits as established the manufacturer.

4.35.2.5 Laying Pipe

All sewer pipe, unless otherwise specified shall be furnished by the CONTRACTOR. The CONTRACTOR will contact the OWNER for approval of pipe delivery and "stringing" plans. Precaution will be taken by the CONTRACTOR to insure that pipe will be kept clean and in good condition until laid and that the pipe shall be stored in a manner causing minimal inconvenience to the public and be satisfactory to the OWNER.

1. Before being lowered into the trench, each pipe section shall be carefully inspected, and those not meeting specifications shall be rejected and removed from the job. All lumps or excrescences on the ends of conduit shall be removed before it is lowered into the trench. Before laying the pipe, the interior of the joints shall be carefully bored smooth and clean and the annular space shall be kept free from dirt, stones or water. Pipe shall be installed and joints made up in complete conformance with the instructions and recommendations regarding proper installation and assembly furnished by the manufacturer. No pipe shall be laid except in the presence of the OWNER, unless otherwise specified; and the OWNER may order the removal of and re-laying of any pipe not so laid.

2. The pipe shall be laid to the line and grade shown on the plans. The pipe shall be laid on the required embedment and shall not vary more than one tenth (1/10) foot from the true line nor more than two hundredths (2/100) foot from the theoretical grades.

3. The embedment to receive the pipe shall be placed to a grade slightly higher than that required for the grade of pipe and the pipe brought to grade by tamping or the removal of the slight excess embedment under the pipe.

4. Lower pipe and accessories into trench by means of derrick, ropes, belt slings, or other equipment approved by the OWNER. Do not dump or drop any of the materials into the trench.

5. Sewers shall be laid with the bell or groove end upgrade unless otherwise approved by the OWNER; and shall be laid with the bell or collar away from the last section placed. Place pipe and fittings in trench so that identifying markings will be visible for inspection.

6. Adjustment to grade and line shall be made by scraping away or filling with embedment material, and wedging up or blocking of pipe will not be permitted. Each pipe section shall have a uniform bearing on the embedment for the full length of the barrel of the pipe. The pipe shall not rest on bells or cap couplings.

7. Do not lay pipe in water or when trench conditions are unsuitable for the work; keep water out of the trench until joining is complete.

8. Securely close open ends of pipe, fittings and valves when work is not in progress.

9. Where any part of the coating or lining is damaged, repair to the approval of the OWNER and at no additional cost to the OWNER.

10. All pipe shall be uniform throughout the circumference of the joint. Where curves in the alignment are indicated on the drawings, standard pipe (short sections of pipe or bevels) shall be used with the outside edge of the joint pulled away from the seat to make a smooth curve.

11. After the pipe has been placed and jointed, the embedment shall be brought to the full depth required. Such part of concrete embedment or encasement where required that may be placed after the pipe is laid, shall be tamped to make a bond with the original concrete, care being exercised in tamping to prevent lifting the pipe out of alignment or grade.

12. Take up and re-lay pipe that has the grade or joint disturbed after laying or has been improperly installed at no additional cost to the OWNER.

13. After embedment is brought to full depth, the trench shall be backfilled as necessary to hold the pipe firmly in position. Such backfilling to be done as herein specified. Concrete embedment shall have acquired its initial set before backfilling.

14. When work is suspended on the line for any reason, the end of the line shall be closed with an effective watertight seal or plug manufactured for the purpose.

15. All existing and/or previously used sewer mains removed by the CONTRACTOR shall be disposed in accordance with Texas Commission on Environmental Quality, Federal, State and local regulations.

4.35.2.6 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.

4.35.2.7 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. Petroleum lubrication shall not be permitted. The spigot shall be forced home in the bell by manufacturer recommended method or other method approved by the OWNER.

4.35.2.8 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.

4.35.2.9 Blocking

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.

4.35.2.10 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 service to customers affected thereby, and as authorized by the OWNER. Facilities shall be provided for proper dewatering and for disposal of all water removed from the dewatered lines and excavations without damage to adjacent property.

4.35.2.11 Pipe Laid on Trench Bottom

Before the pipe is lowered into the trench:

a) A bell hole shall be excavated with sufficient length, width, and depth to permit assembly and provide a minimum clearance of 2 inches below the bell, and

b) The trench bottom shall be graded such that the pipe will be continuously supported between couplings.

4.35.3 Manhole Construction

4.35.3.1 General

Manholes shall be constructed at locations indicted on the plans, or as otherwise directed by the OWNER. Development of areas through which the sewer passes may dictate changes in location or increase the number of manholes required. Manholes shall be constructed to details shown on the plans or described in these specifications. Excavation of manholes shall be as required for complete and proper installation.

4.35.3.2 Manhole Bottoms

Concrete manhole bottoms shall be in accordance with the structural details shown on the plans and in complete conformity with these specifications. Tremies shall be used for drops in excess of six (6) feet. The concrete shall be placed only after the reinforcement has been inspected by the OWNER. The excavation shall be free of water when concrete is placed.

Where indicated on the plans, fiberglass bottom manholes shall be used. See Fiberglass Manhole specifications.

4.35.3.3 Placement of Manhole and Cleanout Castings

All casting frames shall be set true to line and grade, firmly positioned, and grouted in place with mortar as shown on the plans. The mortar shall be kept moist for a minimum period of forth-eight (48) hours. Mortar that does not bond properly with the brick masonry shall be removed and replaced, and prior to acceptance, the brick masonry, mortar, and frame must form one structural unit. The frames for cleanouts shall be set in concrete in accordance with the details shown on the plans, to line and grade as staked. Where required by the OWNER, stub-outs shall be made from the manholes for future connections at the elevation designated by the OWNER, with one joint of pipe which shall be set in the wall of the manhole and plugged at the outer end.

4.35.3.4 Manhole Tie-Ins

All lines entering or exiting manholes shall be fully encased in concrete, bedding condition Type VI as shown in the Drawings, for a minimum distance of two (2') feet from the exterior surface of the manhole wall.

4.35.4 Service Lines

4.35.4.1 General

Service lines shall be installed as shown on the plans and details as specified herein and as needed for a complete and proper installation. The location of the service will be field verified by the OWNER prior to installation and the connection point shall be assumed to end two (2') feet within the property line of the customer to be served.

4.35.5 Testing

4.35.5.1 Testing

All testing shall be completed with the supervision of the OWNER and as directed in the "Sewer Line Testing" section of these documents.

4.35.6 Line and Grade

4.35.6.1 General

The CONTRACTOR shall be responsible for providing horizontal and vertical controls to ensure the proposed sanitary sewer system is constructed in accordance with the plans and specifications. At a minimum, hubs shall be set every 50 feet. CONTRACTOR shall maintain on-site lasers and other equipment to continuously monitor the work to ensure compliance with the lines and grades established on the plans. CONTRACTOR shall retain the services of a Registered Professional Land Surveyor to verify exact manhole depths required, to establish the line, set hubs and to provide cut sheets. CONTRACTOR shall provide a copy of the surveyor's information to the OWNER prior to start of construction activities. Upon request, the City will provide an electronic copy of the project plan and profile sheets. However the lines are not geographically located.

4.35.7 Safety

4.35.7.1 Potentially Harmful Environments

The sanitary sewer system 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, presence of combustible gases, hydrogen sulfide or other toxic gases that may be present. 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.

4.35.8 Measurement and Payment

All work and material furnished under this section will be paid consistent with progress of the Work at the unit price per the Bid Form for Gravity Sewer Main for the actual quantity of units installed as measured by the linear footage along the centerline of the trench.

4.36 - Land Clearing and Grubbing

4.36.1 Description

This Item shall govern for the clearing, grubbing and chipping of all trees, brush, shrubs, snags, logs, stumps, and vegetative rubbish from the designated work area(s) shown on the plans or as directed by the OWNER. The work under this Section includes providing all labor, materials, tools and equipment necessary for clearing, grubbing, chipping, removing, handling, spreading and disposing of all mulched vegetation and debris. The work shall also include the preservation from injury or defacement all vegetation and objects designated to remain.

4.36.2 Clearing, Grubbing and Chipping

Trees and brush shall be removed by grubbing to below the bud zone. For example, trees such as mesquite and cedar shall be grubbed to below the bud zone which is typically fourteen inches (14") below the ground surface. All vegetation (trees, brush, shrubs, snags, logs, stumps, etc.) to be cleared within the work areas shall be chipped at the same time clearing operations are underway. Stockpiling of brush and trees is not permitted. All brush, trees and vegetation cut or removed from the work area shall be chipped immediately.

Chipped material shall be placed within the work area in such a manner as to aid in erosion control but to not impede the reseeding of the disturbed area. Chipping shall reduce all vegetative material to a maximum of one inch (1") in size. Chipped material shall not be placed in cultivated areas or in areas designated by the OWNER.

If feasible, fell trees toward the center of the area being cleared. If this is not possible due to danger to traffic or injury to other trees, structures, or property, cut them into sections from the top down.

Do not injure or damage trees and shrubs designated to be undisturbed. Where required, symmetrically trim lower limbs or branches of trees left in place and overhanging the work area. Prior to trimming any trees outside of the work area but overhanging into the work area, CONTRACTOR shall obtain written permission from the OWNER and the land owner. Trim using generally accepted horticultural practices.

Burning of cleared or mulched material is prohibited without prior written approval from the OWNER, land owner and the governing local, state and/or federal agency. CONTRACTOR is responsible for obtaining all required permissions and/or permits. No burning will be allowed during a burn ban established by the governing agency.

4.36.3 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 work done under this section unless specified.

4.44 - Concrete Curb and Gutter

4.44.0 General

4.44.1 Scope

The work covered by this section includes the replacement of curb, gutter, or combined curb and gutter.

4.44.2 Material

4.44.2.1 Concrete

Concrete used in conventionally formed construction shall be Class A (3,000 psi) concrete with a seven-sack grout topping. Concrete for extruded (machine laid) construction shall be Class A concrete. Membrane curing materials shall be applied.

4.44.2.2 Reinforcing Steel

Reinforcing steel shall be standard billet steel deformed bars with minimum sixty kips per square inch (60 ksi) yield strength and will be required in those areas where the steel already exists, and shall be compatible with the existing sections.

4.44.3 Inspection

It will be the CONTRACTOR's responsibility to provide safe and accurate means to enable inspection forces to take all required samples, and to provide permanent means for checking the output of any specified metering device and to perform these calibration checks as required by the OWNER.

4.44.4 Construction Methods

4.44.4.1 General Requirements

For conventionally formed concrete, the subgrade, foundation, or pavement surface shall be shaped to line, grade, and cross-section of the existing portions, and, if considered necessary by the inspector, hand-tamped and sprinkled. If dry, the subgrade or foundation material shall be sprinkled lightly immediately before concrete is deposited thereon. Outside forms shall be of wood or metal, of a section satisfactory to the OWNER, straight, free of warp and of a depth equal to the depth required. They shall be securely staked to line and grade, and maintained in a true position during the depositing of concrete. Inside forms for curbs shall be of approved material, shall be of such design as to provide the curb required, and shall be rigidly attached to the outside forms. The reinforcing steel, if required, shall be placed in position as required by the site location. Care shall be exercised to keep all steel in its proper location. After the concrete has been struck off and has become sufficiently set, the exposed surfaces shall be thoroughly worked with a wooden float. The exposed edges shall be rounded by the use of an edging tool to the radius indicated on plans. Unless otherwise specified on the plans, when the concrete has become sufficiently set, the inside form for curbs shall be carefully removed and the surface shall be plastered with a seven-sack grout topping. The mortar shall be applied with a template made to conform to the dimensions of the existing curb. All exposed surfaces shall be brushed to a smooth and uniform surface. Membrane curing materials shall be applied. All concrete placed under the

item shall contain 7% + 1-1/2% entrained air. The completed work shall be cured for a period of not less than seventy-two (72) hours.

4.44.5 Measurement and Payment

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

4.45 - Concrete Pavement

4.45.0 General

4.45.1 Scope

The work covered by this section includes all necessary operations and materials involved with placing a concrete cap or rigid pavement at locations as required.

4.45.1.1 Concrete Cap

Concrete caps shall be used when specified by the OWNER, in areas where major traffic lanes create excessive wheel-loading or where compaction of the base and sub-base is prone to failure.

4.45.1.2 Rigid Pavement

Rigid Pavement shall be used when specified by the OWNER and in repair of utility trenches cut in rigid pavement.

4.45.2 Material

4.45.2.1 Concrete & Reinforcement

Concrete type, thickness and reinforcement shall be in consistent with these specifications and the project Drawings.

4.45.2.2 Curing Material

All concrete shall be treated with a curing material capable of protecting the pavement from loss of moisture for a period of not less than seventy-two (72) hours.

4.45.2.3 Reinforcement Steel

Reinforcing steel shall be standard billet steel deformed bars with a minimum of sixty kips per square inch (60 ksi) strength.

4.45.3 Construction Methods

4.45.3.1 Concrete Caps

Concrete caps shall be six inches (6") in thickness and of a length and width sufficient to extend a minimum of six inches (6") beyond the edge of the utility trench. The concrete shall be properly placed and finished in accordance with OWNER's specifications and shall be allowed to cure without disturbance for a period of not less than seventy-two (72) hours.

4.45.3.2 Rigid Pavement

Rigid pavement shall be concrete a minimum of six inches (6") in thickness and extending twelve inches (12") each way transverse to the utility trench placed over existing subgrade. In order that the quality of the replacement pavement shall be consistent with or exceed the quality of the original pavement, reinforcement bar sizes shall be equal to or larger than those in the existing pavement and at locations as close to the original installation as feasible. In no case shall reinforcement bars be smaller than #4 and on spacings greater than twelve inches (12") each way. New rigid pavement shall be doweled a minimum of twelve inches (12") into existing rigid pavement with minimum #4 bars twenty-four inches (24") in length on twelve inch (12″) centers.

The concrete shall be properly placed and finished in accordance with OWNER's specifications and shall be allowed to cure without disturbance for a period of not less than seventy-two (72) hours.

4.45.4 Measurement and Payment

All work and material furnished for Concrete Caps 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 unless specified.

All work and material furnished under this section for Concrete Pavement will be paid consistent with progress of the work at the unit price per the Bid Form for Concrete Pavement Repair for the actual quantity of units installed as measured by the linear footage along the centerline of the trench within existing asphalt pavement multiplied by the trench width indicated on the Plans.

4.47 - Concrete Driveways and Turnouts

4.47.0 General

4.47.0.1 Scope

This Item shall govern for the construction of new driveways and turnouts or the removal and replacement of driveways and turnouts. Driveways and turnouts shall be concrete of the design type specified and shall be constructed according to the Typical Sections and Details.

4.47.1 Materials

Base, stabilized base, asphalt surfacing, concrete pavement, reinforcing steel and other materials shall conform to the material requirements of the pertinent items.

4.47.2 Construction Methods

The driveways and turnouts shall be constructed according to the Typical Sections and Details. Unless otherwise directed by the OWNER, the CONTRACTOR shall provide uninterrupted access to the adjacent property.

Stabilization of subgrade will be required where specified on the plans in accordance with the construction methods of the pertinent stabilization items.

Base material shall be placed on the subgrade, sprinkled, bladed compacted and shaped to conform to the typical sections shown on the plans and specified in the construction methods of the pertinent base item.

The subgrade, foundation, or pavement surface shall be shaped to line, grade and cross sections and constructed in accordance with the details shown on the plans.

When concrete pavement is specified on the plans it shall be in accordance with the construction methods of the “Cast in Place Concrete” specification. Reinforcing steel shall be placed as shown on the detail drawings. Care shall be exercised to keep all steel in its proper location during concrete placement. Hand finishing will be permitted.

4.47.3 Payment

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

4.48 - HDPE Pipe

4.48.0 General

4.48.1 Scope

This section covers the furnishing and installation of High-Density Polyethylene (HDPE) pipe. The Plans show the sizes and general arrangement of all pipes; however, the responsibility for furnishing exact lengths of the various pipes for proper "make-up" rests with the CONTRACTOR.

4.48.2 Material Specifications

The pipe and fittings shall be supplied and installed in accordance with the following standards:

a) AWWA C906 “Polyethylene pipe and fittings, 4 inch through 63 inch for water distribution”.

b) ASTM F714 “Standard specification for polyethylene pipe (SDR PR) based on outside diameter”.

c) ASTM F1962 “Standard guide for use of maxi-horizontal direction drilling for placement of polyethylene pipe or conduit under obstacles, including river crossings”.

d) ASTM D2774 “Standard practice for underground installation of thermoplastic pressure piping”.

e) ASTM F2164 “Standard practice for field leak testing of polyethylene (PE) pressure piping systems using hydrostatic pressure”.

f) ASTM F2620 “Standard practice for heat fusion of polyethylene pipe and fittings”.

g) ASTM D3261 “Standard specification for butt heat fusion polyethylene (PE) plastic fittings for polyethylene (PE plastic pipe and tubing”.

h) ASTM D3350 “Standard specification for polyethylene plastic pipe and fitting materials” Pipe and fittings shall be PE4710 (ASTM F714) high density polyethylene.

i) With a minimum cell classification of 445574C as determined by ASTM D3350, DIPS (Ductile Iron Pipe Size).

Resin:

Pipe and fittings shall be PE4710 (ASTM F714) high density polyethylene, with a minimum cell classification of 445574C as determined by ASTM D3350, IPS (Iron Pipe Size).

a) Color material (if required) shall be PE4710 (ASTM F714) high density polyethylene, with a minimum cell classification of 445574E as determined by ASTM D3350.

b) Pressure class and wall thickness as indicated on the Drawings.

Pipe Marking:

Force main pipe shall be black with a minimum of one continuous, integral green stripe longitudinally along the pipe.

During extrusion production, the HDPE pipe shall becontinuously marked with durable printing following this format or an equal type format designating the same information:

a) Manufacturer name or trademark.
b) Nominal Size.
c) Sizing System – IPS or DIPS.
d) Dimension Ratio.
e) Standard Designation – ASTM, AWWA, or other.
f) Material Classification.
g) Certification Bases, e.g. NSF-61.
h) Plant.
i) Extruder Number.
j) Date.
k) Shift Letter.

EXAMPLE: PIPELINE PLASTICS 12" IPS SDR 11, PE4710 PC200 AWWA C906 ASTM F714 NSF-61 TXL1 A052015

4.48.3 General Installation

HDPE pipe and fittings are to be installed at locations shown on Plans. The trench bottom should be smooth and free from stones greater than two inches (2") in diameter and large dirt clods. If the trench bottom is rocky or hard, as in shale, a four inch (4") layer of embedment material shall be placed to provide a cushion for the pipe. All pipe, fittings, and specials shall be lowered into the trench by some suitable means, and shall not be rolled or dumped into trench. All dirt or trash shall be removed from the ends of the pipe. Any damaged, defective or unsound material shall be suitably repaired or replaced before use. 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 restricted to 75% of maximum deflection limits established by the manufacturer. The pipe is to be kept clean during the laying operation and free of all sticks, dirt and trash, and at the close of each operating day, the open end of the pipe is to be effectively sealed against the entrance of all obstructions and especially water. Any pipe that becomes contaminated before or after installation shall be removed and replaced unless a method to clean the pipe is approved by the OWNER. If any gouges, scrapes, or other damage to the pipe results in loss of 10% of the pipe wall thickness, that section should be cut out, discarded, and replaced by the CONTRACTOR.

4.48.4 Bedding & Backfill

Buried HDPE pipe and fittings shall be installed in accordance with ASTM D2321 or ASTM D2774 for pressure systems and AWWA Manual of Practice M55 Chapter 7.

Pipe embedment and backfill shall be in accordance with these Specifications.

4.48.5 Fittings and Connections

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 service to customers affected thereby, and as authorized by the OWNER. Facilities shall be provided for proper dewatering and for disposal of all water removed from the dewatered lines and excavations without damage to adjacent property.

a) Butt fusion fittings shall meet the requirements of ASTM D3261. Molded and fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans. All fittings shall meet the requirements of AWWA C906.

b) Connections from HDPE pipe to valves or other pipe materials shall be made with flange adapters or mechanical joint adapters. Flange adpaters and MJ adapters shall be made from PE4710 material with no visible voids or inclusions. MJ adapters shall have an internal stainless steel stiffener.

c) Convoluted back up rings shall be used with HDPE flange adapters and shall follow the dimensions as per ANSI B 16.5 class 150 and shall be made from Stainless Steel as per ASTM A 351 CF8M (316).

d) Tie-ins between sections of HDPE pipe shall be made by butt fusion whenever possible. If butt fusion is not possible, sections shall be joined by flange adapters and convoluted back up rings. Mechanical restraint-type fittings are not allowed. Electrofusion couplings are not allowed, unless approved in advance by the OWNER.

e) Flange bolts. ASTM A193 Class 2, AISI Type 316, ANSI B18.2.1, heavy hex head, length such that, after installation, the bolts will project 1/8 to 3/8 inch beyond outer face of the nut. Flange Nuts ASTM A194, AISI Type 316, ANSI/ASME B18.2.2, heavy hex pattern. Washers shall be installed under the nuts.

f) Flange adapters shall be assembled and torqued according to PPI TN-38, “Bolt torque for polyethylene flanged joints.”

4.48.6 Testing

Hydrostatic Tests - After installation, HDPE piping shall be hydrostatically tested for defective workmanship and materials. Hydrostatic leak testing shall comply with ASTM F2164.

HDPE force main piping shall be tested at 150 PSI for 4 hours.

Leakage - All HDPE piping shall be watertight and free from leaks. Each leak that is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of CONTRACTOR.

4.48.7 Fusion Procedures

This specification is intended to insure quality HDPE fusion welds are achieved. A properly trained fusion operator will use properly maintained equipment. Verification of sample joints can be destructively tested and records of all fusion joints can be reviewed against accepted fusion variables.

A fusion procedure that follows the guidelines of ASTM F 2620 Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings must be documented on company letterhead.

A record or certificate of training for the fusion operator must be provided that documents training to the fundamentals of ASTM F 2620.

4.48.8 Fusion Operator

All HDPE fusion equipment operators shall be qualified to perform pipe joining. Fusion equipment operators shall have current, formal training on all fusion equipment employed on the project. Training received more than two years prior to operation with no evidence of activity within the past 6 months shall not be considered current. All operators shall be familiar with the requirements outlined in ASTM F 2620 and the HDPE supplier's requirements for fusion.

When the fusion machine operator is employed by the HDPE pipe and fusion machine supplier, the supplier shall maintain an ISO 9001 Certified Quality Management System.

4.48.9 Fusion Performance Qualification

Visual Examination:

For pipe sections, examine the full exterior circumference for bead uniformity before cutting. After cutting the pipe section, review the interior bead. All beads should have visually acceptable bead formation as shown in Fig 4 and Appendix X2 of ASTM F2620. In addition, the following characteristics are expected:

a) There shall be no evidence of cracks or incomplete fusing.

b) Variations in upset bead heights on opposite sides of the cleavage and around the circumference of fused pipe joints are acceptable.

c) The apex of the cleavage between the upset beads of the fused joint shall remain above the base material surface.

d) Fused joints shall not display visible angular misalignment, and outside diameter mismatch shall be less than 10% of the nominal wall thickness.

Mechanical Tests:

Each pipe sample weld maybe subjected to testing at two locations 180 degrees apart from each other in the joint weld. All samples shall be labeled with operator information. Testing must be done at 73 degrees F plus or minus 5 degrees. The test temperature and sample size are critical to testing. Testing performed at cold or elevated temperatures may not give similar results to tests performed at ambient temperatures. Results of any mechanical test should be documented. Information on the weld and operator should be transferred from the sample to the testing record. All specimens maybe tested by one of the following methods:

a) Reverse Bend Test are allowed for pipe sizes 6" IPS or smaller. The specimens shall be removed and tested in accordance with ASTM F 2620, Appendix X4.

b) Guided Side Bend Test are allowed for all pipe sizes 4" IPS and larger. The specimens shall be removed and tested in accordance to standard methods.

c) High Speed Tensile Impact Test is allowed for pipe sizes 3"-63" for all wall thicknesses less than 2.5". The specimens shall be removed and tested in

accordance to ASTM F 2634.

d) Hydrostatic Burst Test is allowed for pipe sizes 2"-24". The specimen length should measure 6 times pipe diameter with the butt fusion joint in the center of the specimen. The specimen should be tested in a tank filled with water, and testing conditions monitored and recorded with computerized equipment. The specimen will be tested at 4 times pipe rated pressure for 5 minutes with no failure of joint allowed.

Records showing the fusion device is up to date on all required calibration should be available for presentation when requested. All fusion welds should be traceable to the report (via operator and weld ID) with an indentation weld stamp or by permanent paint marker/pen next to fusion weld. When requested prior to commencement of work, a weld location map may requested by the OWNER or OWNER's representative.

If the recorded data is outside the limits of the acceptable range, the joint is unacceptable.

Records for test fusion joints should be reviewed immediately after the joint is completed. Fusion joints for jobsite fusions should be reviewed daily or before being covered with backfill

4.48.10 Measurement and Payment

All work and material furnished under this section will be paid consistent with progress of the Work at the unit price per the Bid Form for HDPE Force Main for the actual quantity of units installed as measured by the linear footage along the centerline of the trench.

The measurement of pipe for payment purposes will be the horizontally measured length of the line along its main axis from center of fitting to center of fitting or end of pipe, without deduction for the length of intermediate fittings or valves. Payment will include full compensation for excavation, embedment, backfill, separation of excavated material for backfill according to the Specifications, asphalt/concrete repair, surface restoration (unless specified elsewhere) furnishing, hauling and laying pipe, fittings, testing, disinfection, etc., in accordance with the specifications, Plans, and/or instructions of the OWNER.

4.49 Weighted Collars

4.49.0 General

4.49.1 Scope

This section covers the furnishing and installation of weighted collars. The intent of the weighted collars is for submersion of periodic drained pipe and maintaining the pipe below a surface water body during and after construction operations.

4.49.2 Material Specifications

The weighted collars shall be constructed and designed such that it meets all AWWA standards (as applicable) and to resist the uplift buoyant forces exerted on an empty pipe, diameter shown on plans. All mechanical measures used to secure the weighted collars to the pipe shall be resistant to corrosion when fully submerged in water and constructed to prevent sliding along the pipe during and after installation.

Material specifications shall be submitted to the OWNER, for review and approval, prior to the start of any construction. The OWNER will provide written approval. The material specification shall be submitted (at a minimum) on the manufacturer's letterhead with the manufacturer's contact information.

4.49.3 General Installation

Installation method shall be determined by the CONTRACTOR. The selected method of construction shall be submitted, in writing, to the OWNER three (3) weeks prior to construction for review and approval. The OWNER shall have a minimum of one (1) week to review construction method. The installation method shall be within standard installation procedures and as recommended by the manufacturer.

Installation shall not damage the integrity of the pipe in any manner. If the integrity of the pipe is compromised, replacement of the pipe and/or collar will be the responsibility of the CONTRACTOR.

4.49.4 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 work done under this section unless specified.

4.53 – Hydraulically-Applied Erosion Control: High Performance-Flexible Growth Medium

4.53.0 General

4.53.0.1 Summary

a) This section specifies a hydraulically-applied, 100% biodegradable, High Performance-Flexible Growth Medium (HP-FGM) that is manufactured in the United States and is composed of 100% recycled thermally refined (within a pressure vessel) wood fibers, crimped interlocking man-made biodegradable fibers, mineral activators, naturally derived crosslinked biopolymers and water absorbents. The HP-FGM is phytosanitized, free from plastic netting, requires no curing period and upon application forms an intimate bond with the soil surface to create a continuous, porous, absorbent and flexible erosion resistant blanket that allows for rapid germination and accelerated plant growth

4.53.0.2 Submittals

a) Product Data: Submit manufacturer's product data and installation instructions. Include required substrate preparation, list of materials and application rate.

b) Certifications: Manufacturer shall submit a letter of certification that the product meets or exceeds all technical and packaging requirements.

4.53.0.3 Delivery, Storage and Handling

a) Deliver materials and products in UV and weather-resistant factory labeled packages. Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from damage, weather, excessive temperatures and construction operations.

4.53.1 Products

4.53.1.1 Acceptable Manufacturer

PROFILE Products LLC or approved equal

750 Lake Cook Road – Suite 440
Buffalo Grove, IL 60089
800-366-1180 (Fax 847-215-0577)
www.profileproducts.com

4.53.1.2 Materials

a) The HP-FGM shall be Flexterra® HP-FGM and conform to the following property values when uniformly applied at a rate of 3500 pounds per acre (3900 kilograms/hectare) under laboratory conditions.

Property	Test Method	Req. Value (English)	Req. Value (SI)
Physical			
Mass Per Unit Area	ASTM D6566[1]	12 oz/yd^2 minimum	407 g/m^2 minimum
Thickness	ASTM D6525[1]	0.22 inch minimum	5.6 mm. minimum
Wet Bond Strength	ASTM D6818[1]	9 lb/ft	131 N/m
Ground Cover	ASTM D6567[1]	99% minimum	99% minimum
Water Holding Capacity	ASTM D7367	1700% minimum	1700% minimum
Material Color	Observed	Green	Green
Performance			
Cover Factor[2]	Large Scale Testing[4]	0.01 maximum	0.01 maximum
% Effectiveness[3]	Large Scale Testing[4]	99 % minimum	99 % minimum
Cure time	Observed	0 - 2 hours	0 - 2 hours
Vegetation Establishment	ASTM D7322[1]	800 % minimum	800 % minimum
Yield[5]	Calculated	2.6 minimum	2245 minimum
Kinetic Energy Absorption Potential[6]	Calculated	2.0 minimum	734 minimum
Environmental			
Functional Longevity[7]	ASTM D5338	Up to 18 months	Up to 18 months
Ecotoxicity	EPA 2021.0	96-hr LC50 > 100%	96-hr LC50 > 100%
Effluent Turbidity	Large Scale Testing[4]	100 NTU maximum	100 NTU maximum
Biodegradability	ASTM D5338	100% minimum	100% minimum

1. ASTM test methods developed for Rolled Erosion Control Products and have been modified to accommodate Hydraulically-Applied Erosion Control Products.

2. Cover Factor is calculated as soil loss ratio of treated surface versus an untreated control surface.

3. % Effectiveness = One minus Cover Factor multiplied by 100%.

4. Large scale testing conducted at Utah Water Research Laboratory. For specific testing information please contact a Profile technical service representative at 866-325-6262.

5. Yield = (Mass per Unit Area)*(Thickness)*(Ground Cover Percentage).

6. Kinetic Energy Absorption Potential = (Wet Bond Strength)*(Thickness)

7. Functional Longevity is the estimated time period, based upon ASTM D5338 testing and field observations, that a material can be anticipated to provide erosion control and agronomic benefits as influenced by composition, as well as site-specific conditions, including; but not limited to – temperature, moisture, light conditions, soils, biological activity, vegetative establishment and other environmental factors.

4.53.1.3 Composition

a) All components of the HP-FGM shall be pre-packaged by the Manufacturer to assure both material performance and compliance with the following values. No chemical additives with the exception of fertilizer, soil pH modifiers, extended-term dyes and biostimulant materials should be added to this product.

1. Thermally Processed (within a pressure vessel) Wood Fiber – 80% + 3%.

   - Heated to a temperature greater than 380 degrees Fahrenheit (193 degrees Celsius) for 5 minutes at a pressure greater than 50 psi (345 kPa).

   Crosslinked Biopolymers and Water Absorbents – 10% + 1%

   Crimped, Man-made Biodegradable Interlocking Fibers – 5% + 1%

   Micro-Pore Granules – 5% + 1%

4.53.1.4 Packaging

a) Bags: Net Weight – 50 lb, UV and weather-resistant plastic film

   Pallets: Weather-proof, stretch-wrapped with UV resistant pallet cover.

   Pallet Quantity: 40 bags/pallet or 1 ton/pallet.

4.53.2 Execution

4.53.2.1 Substrate and Seedbed Preparation

a. Examine substrates and conditions where materials will be applied. Apply product to geotechnically stable slopes that have been designed and constructed to divert runoff away from the face of the slope. Do not proceed with installation until satisfactory conditions are established.

b. Depending upon project sequencing and intended application, prepare seedbed in compliance with other specifications under Section 1.01 B.

4.53.2.2 Installation

a) Strictly comply with equipment manufacturer's installation instructions and recommendations. Use approved hydro-spraying machines with fan-type nozzle (50-degree tip). To achieve optimum soil surface coverage, apply HP-FGM from opposing directions to soil surface. Rough surfaces (rocky terrain, cat tracks and ripped soils) may require higher application rates to achieve 100% cover. Slope interruption devices or water diversion techniques are recommended when slope lengths exceed 100 feet (30 m). Maximum slope length is for product applications on a 3H:1V slope. For application on steeper slopes, slope interruption lengths may need to be decreased based on actual site conditions. Not recommended for channels or areas with concentrated water flow. This product may be applied on saturated soils and does not require a curing period to be effective. No chemical additives with the exception of

fertilizer, liming and biostimulant materials should be added to this product.

b) For Erosion Control and Revegetation: To ensure proper application rates, measure and stake area. For maximum performance, apply HP-FGM in a two-step process*:

1. Step One: Apply fertilizer with specified prescriptive agronomic formulations and 50% of seed with a small amount of HP-FGM for visual metering.

2. Step Two: Mix balance of seed and apply HP-FGM at a rate of 50 lb per 125 gallons (23 kg/475 liters) of water over freshly seeded surfaces. Confirm loading rates with equipment manufacturer. Do not leave seeded surfaces unprotected, especially if precipitation is imminent.

*Depending upon site conditions HP-FGM may be applied in a one-step process where all components may be mixed together in single tank loads. Consult with Manufacturer for further details.

Best results and more rapid curing are achieved at temperatures exceeding 60°F (15°C). Curing times may be accelerated in high temperature, low humidity conditions with product applied on dry soils.

Over-application of product may inhibit germination and plant growth.

c) Mixing: A mechanically agitated hydraulic-application machine is strongly recommended:

1. Fill 1/3 of mechanically agitated hydroseeder with water. Turn pump on for 15 seconds and purge and pre-wet lines. Turn pump off.

2. Turn agitator on and load low density materials first (i.e. seed).

3. Continue slowly filling tank with water while loading fiber matrix into tank.

4. Consult application and loading charts to determine number of bags to be added for desired area and application rate. Mix at a rate of 50 lb of HP-FGM per 125 gallons (23 kg/475 liters). Contact Equipment manufacturer to confirm optimum mixing rates.

5. All HP-FGM should be completely loaded before water level reaches 75% of the top of tank.

6. Top off with water and mix until all fiber is fully broken apart and hydrated (minimum of 10 minutes — increase mixing time when applying in cold conditions). This is very important to fully activate the bonding additives and to obtain proper viscosity.

7. Add fertilizer.

8. Shut off recirculation valve to minimize potential for air entrainment within the slurry.

9. Slow down agitator and start applying with a 50-degree fan tip nozzle.

10. Spray in opposing directions for maximum soil coverage.

d) Application Rates: These application rates are for standard conditions. Designers may wish to reduce rates to encourage faster vegetation establishment or may need to increase application rates on rough surfaces.

Slope Gradient / Condition	English	SI
< 4H to 1V	2500 lb/ac	2800 kg/ha
> 4H to 1V and < 3H to 1V	3000 lb/ac	3400 kg/ha
> 3H to 1V and < 2H to 1V	3500 lb/ac	3900 kg/ha
> 2H to 1V and < 1H to 1V	4000 lb/ac	4500 kg/ha
> 1H to 1V	4500 lb/ac	5100 kg/ha
Below ECB or TRM	1500 lb/ac	1700 kg/ha
As infill for TRM*	3500 lb/ac	3900 kg/ha

*Use only approved and tested TRMs to create the GreenArmor™ System

4.53.2.3 Cleaning and Protection

a) After application, thoroughly flush the tank, pumps and hoses to remove all material. Wash all material from the exterior of the machine and remove any slurry spills. Once dry, material will be more difficult to remove.

b) Clean spills promptly. Advise owner of methods for protection of treated areas. Do not allow treated areas to be trafficked or subjected to grazing.

4.53.3 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 work done under this section unless specified.

4.60 – Cast-in-Place-Pipe Rehabilitation System

4.60.0 General

4.60.1 Scope

It is the intent of this specification to provide for the reconstruction of pipelines and conduits by the installation of a resin-impregnated flexible tube that is either inverted or pulled into the original pipeline/conduit and expanded to fit tightly against said pipeline by the use of water or air pressure. The resin system shall then be cured by elevating the temperature of the fluid (water/air) used for the inflation to a sufficient enough level for the initiators in the resin to effect a reaction. The finished pipe shall be such that when the thermosetting resin cures, the total wall thickness shall be a homogeneous and monolithic felt and resin composite matrix, chemically resistant to withstand internal exposure to domestic sewage or stormwater.

4.60.2 Qualifications

Since sewer products are intended to have a 50-year plus design life, and in order to minimize the OWNER's risk, only proven products with substantial successful installations and experience will be approved. In order for the CIPP product and Installation Contractor to be deemed commercially acceptable and approved for this project, they must meet the following criteria:

A. CIPP Product

a. The CIPP product must have been installed in a minimum of 5,000,000 linear feet or 4,000 manhole to manhole line sections of successful wastewater collection systems in North America and must be documented to the satisfaction of the OWNER.

b. The CIPP product shall comply with the latest versions of ASTM F1216 or ASTM F1743, including appendices.

c. For the CIPP to be considered Commercially Proven, it shall have been successfully in service in an application similar to this project for a minimum of 10 years and documented to the satisfaction of the OWNER.

d. The lining tube manufacturer shall operate under a quality management system that is third party certified to ISO 9001 or other internationally recognized organization standards. Proof of certification shall be submitted with the CONTRACTOR's bid and required for approval.

e. Third-party test results supporting the structural properties and long-term performance of the CIPP product shall be submitted for approval, and such data shall be satisfactory to the OWNER. No CIPP product will be approved without independent third party testing verification.

B. Installation Contractor

a. The Installation Contractor shall be certified by the CIPP product manufacturer to have had at least 5 years active experience in the installation of the proposed CIPP product.

b. The Installation Contractor shall satisfy all insurance, financial and bonding requirements of the OWNER, and shall have installed within the United States a minimum of 1,000,000 lineal feet of the same CIPP product being represented by the bidder.

c. The Installation Contractor superintendent(s) designated for the project shall have installed a minimum of 100,000 lineal feet and shall have 5 years of installation experience of the same CIPP product being represented by the bidder. This shall be documented to the OWNER's satisfaction in the form of a resume of work experience detailing scope of work (linear footage and pipe diameters), location of work, and reference contact information for each project listed.

d. The Installation Contractor shall operate under a quality management system that is third party certified to ISO 9001 or equivalent standards. Proof of certification or quality management system shall be submitted with the CONTRACTOR's bid and required for approval.

4.60.3 Structural Requirements

A. Each CIPP shall be designed to withstand internal and/or external loads as dictated by the site and pipe conditions. Unless specified differently by the OWNER in the contract documents, the design thickness of the CIPP shall be derived at using standard engineering methodology as found in ASTM F1216, Appendix X1. The long-term flexural modulus shall not exceed 50 percent of the short-term value for the CIPP resin system and shall be substantiated through third-party testing. The thickness calculations, signed and sealed by a Professional Engineer, registered in the state of Texas, shall be submitted to the OWNER prior to CIPP installation.

B. The layers of the finished CIPP shall be uniformly bonded. It shall not be possible to separate any two layers with a probe or point of a knife blade so that the layers separate cleanly or such that the knife blade moves freely between the layers. If separation of the layers occurs during testing of the field samples, new samples will be cut from the work. Any reoccurrence may be cause for rejection of the work.

C. The Enhancement Factor 'K' to be used in the CIPP design shall be assigned a value of 7.

D. Long-term testing in general accordance with ASTM D2990 must have been performed for flexural creep of the CIPP pipe material to be installed. Such testing results are to be used to determine the long-term, time dependent flexural modulus to be utilized in the product design. This is a performance test of the materials (CIPP Tube and Resin) and general workmanship of the installation and curing as defined within the relevant ASTM standard. A percentage of the instantaneous flexural modulus value (as measured by ASTM D790 testing) will be used in design calculations for external buckling. The percentage, or the long-term creep retention value utilized, will be verified by this testing. The materials utilized for the contracted project shall be of a quality equal to or better than the materials used in the long-term test with respect to the initial flexural modulus used in the CIPP design.

E. The CIPP shall meet the following minimum strength requirements:

Minimum Physical Properties				
Property	ASTM Test Method	Polyester System	Filled Polyester System	Vinyl Ester System
Flexural Strength	D790	4,500 psi	4,500 psi	5,000 psi
Flexural Modulus (initial)	D790	250,000 psi	400,000 psi	300,000 psi
Flexural Modulus (50-year)	D790	125,000 psi	200,000 psi	150,000 psi

F. The required CIPP wall thickness shall be based as a minimum on the physical properties in Section 1.3.E above, and in accordance with the design equations in the Appendix X1 of ASTM F1216.

4.60.4 Materials

A. CIPP Tube

1. The CIPP tube shall consist of one or more layers of a flexible needled felt or an equivalent nonwoven or woven material, or a combination of nonwoven and woven materials, capable of carrying resin, withstanding installation pressures and curing temperatures. The CIPP tube should be compatible with the resin system to be used on this project. The material should be able to stretch to fit irregular pipe sections and negotiate bends.

2. The CIPP tube should be fabricated under controlled conditions to a size that, when installed, will tightly fit the internal circumference and the length of the original conduit. Allowances should be made for the longitudinal and circumferential stretching that occurs during placement of the tube. Maximum stretching allowances shall be as defined in ASTM F1216 or ASTM F1743. The Installation Contractor shall verify the lengths in the field before cutting the liner to length. Continuous individual liners can be made over one or more manhole to manhole sections.

3. The CIPP tube shall be uniform in thickness and when subjected to the installation pressures shall meet or exceed the designed wall thickness.

4. Any plastic film applied to the tube on what will become the interior wall of the finished CIPP shall be compatible with the resin system used, translucent enough that the resin is clearly visible, and shall be firmly bonded to the felt material.

5. At time of manufacture, each lot of CIPP tube shall be inspected and certified to be free of defects. The tube shall be marked for distance at regular intervals along its entire length, not to exceed five feet. Such markings shall also include the CIPP tube Manufacturer's name or identifying symbol.

6. The CIPP tube may be made of single or multiple layer construction where any layer must not be less than 1.5 mm thick. A suitable mechanical strengthener membrane or strip may be placed in between layers where required to control longitudinal stretching.

B. Resin Components

1. The resin system shall be a corrosion resistant polyester or vinyl ester, along with a compatible catalyst system.

2. The resin used shall not contain non-strength enhancing fillers.

3. When combined with the CIPP tube, the resin system shall provide a CIPP that meets the structural requirements of ASTM F1216 or ASTM F1743, the minimum physical properties specified in Section 1.3.E, and those properties which are to be utilized in the design of the lining system for this project.

4. When combined with the CIPP tube, the resin system shall provide a CIPP that complies with the chemical resistance requirements specified in ASTM F1216 or ASTM F1743.

4.60.5 Storage and Handling

A. The Installation Contractor shall deliver the resin impregnated CIPP tube to the site and provide all equipment required to insert and cure the CIPP within the host pipe. The Installation Contractor shall designate a location where the tube will be vacuum impregnated with the resin prior to installation. If requested by the OWNER, the Installation Contractor shall notify the OWNER at least 48 hours prior to wet out to allow the OWNER's representative to observe the materials and wet out procedure. All procedures to prepare the CIPP for installation shall be in strict accordance with the Manufacturer's recommendations.

B. The CIPP shall be vacuum impregnated with resin not more than 120 hours before the time of installation and stored out of direct sunlight at a temperature of less than 70° F.

4.60.6 Notification and Preparation

A. The Installation Contractor shall notify all residents affected by this construction at least 24 hours prior to any service disruption affecting their service connection. The Installation Contractor shall make every effort to maintain service usage throughout the duration of the project.

B. The Installation Contractor shall perform cleaning, video, and inspection prior to installation of the CIPP. The Installation Contractor, when required, shall remove all debris from within the pipe that will interfere with the installation of the CIPP. The CONTRACTOR shall provide a dumpsite for such debris removed during the cleaning operations.

C. It shall be the responsibility of the Installation Contractor to notify the OWNER of line obstructions, offset joints or collapsed pipe that will prevent the insertion of the tube or significantly reduce the capacity of the sewer. The OWNER, with input from the Installation.

D. CONTRACTOR shall determine the method of pipe repair required and shall address these concerns on a case-by-case basis.

E. Protruding laterals or services shall be trimmed flush with the inside of the main sewer wall prior to installation of the CIPP. Trimming shall not cause damage to the lateral or service beyond the inside face of the main sewer.

4.60.7 Bypass Pumping

A. The CONTRACTOR, when required, shall provide for the flow of sewage around the section or sections of pipe designated for repair. When possible, the bypass shall be made by plugging the line at an existing upstream manhole and pumping the flow into a downstream manhole or adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle the flow. The CONTRACTOR shall furnish all necessary pumping equipment, conduit, etc. to adequately, safely, and environmentally divert sewage flow around the work.

B. CONTRACTOR shall prepare and submit a bypass pumping plan (BPP) for each phase of construction. Implementation and maintenance of bypass pumping operations shall be the responsibility of the CONTRACTOR throughout construction.

4.60.8 Television Inspection

A. The Installation Contractor shall provide video equipment capable of properly documenting the conditions as found within the pipe. Lighting for the video camera shall illuminate the entire periphery of the sewer. The camera shall be radial view type capable of viewing 360° within the pipe and shall provide an unobstructed view of the full pipe.

B. The video shall begin with a clear identification of the pipeline location, upstream and downstream manhole designation, and pipe diameter. The video shall provide an accurate length measurement of the entire segment and of the distance to each lateral connection. The Installation Contractor shall pan all lateral connections on both the pre and post-videos.

C. Reverse video set-ups shall be utilized when line obstructions prevent full segment televising from the initial set-up direction.

D. Both a pre-lining and post-lining video shall be submitted to the OWNER for approval. The discs shall be clearly and properly labeled.

4.60.9 Installation

A. The CIPP shall be installed in accordance with the practices given in ASTM F1216 (for direct inversion installations) or ASTM F1743 (for pulled-in-place installations). The quantity of resin used for the tube's impregnation shall be sufficient to fill the volume of air voids in the CIPP tube with additional allowances being made for polymerization shrinkage and the loss of any resin through cracks and irregularities in the original pipe wall. A vacuum impregnation process shall be used in conjunction with a roller system to achieve a uniform distribution of the resin throughout the CIPP tube.

B. The resin-impregnated CIPP tube shall be installed into the host pipe by methods specified in ASTM F1216 or ASTM F1743 and proven through previous successful installations. The insertion method shall not cause abrasion or scuffing of the CIPP tube. Hydrostatic or air pressure shall be used to inflate the CIPP tube and mold it against the walls of the host pipe. There will be no use of sewage in place of clean water for insertion of the tube, or for the curing of the liner.

C. Temperature gauges shall be placed between the CIPP tube and the host pipe's invert position to monitor the temperatures during the cure cycle.

4.60.10 Curing

A. After the CIPP tube installation is completed, the Installation Contractor shall supply a suitable heat source and recirculation equipment (if required). The equipment shall be capable of delivering hot water or steam throughout the section to uniformly raise the temperature above the temperature required to affect a cure of the resin.

B. The heat source shall be fitted with suitable monitors to gauge the temperature of the incoming and outgoing heat supply (for water cure) and outgoing heat supply (for steam cure). Water or air temperature in the pipe during the cure period shall be as recommended by the resin Manufacturer.

C. Initial cure shall be deemed to be completed when inspection of the exposed portions of the CIPP appears to be hard and sound and the remote temperature sensor(s) indicates that the temperature is of a magnitude to realize an exotherm. The cure period shall be of a duration recommended by the resin Manufacturer, as modified for the installation process, during which time the recirculation of the heat and/or cycling of the heat exchanger to maintain the temperature is continued.

4.60.11 Cool Down

A. Cool down may be accomplished by the introduction of cool water or air to replace water or pressurized air being relieved. Care shall be taken in the release of the hydrostatic head so that a vacuum will not be developed.

4.60.12 Finish

A. The finished CIPP shall be continuous over the entire length of an insertion run and be as free as commercially practical from visual defects such as foreign inclusions, dry spots, pinholes, and delamination. The CIPP shall be homogeneous, and free of any leakage from the surrounding ground to the inside of the CIPP.

B. Where the CIPP is installed through a manhole uninterrupted, the invert shall be maintained smooth within the manhole, with approximately the bottom half of the CIPP continuous through the length of the manhole. The invert of the manhole shall be shaped and grouted as necessary to support the liner. The cost of this work shall be included in the CIPP unit price.

C. During the warranty period, any defects which will affect the integrity or strength of the CIPP, collect solids, or reduce hydraulic flow capabilities of the product shall be repaired at the Installation Contractor's expense in a manner mutually agreed upon by the OWNER and the Installation Contractor.

4.60.13 Reinstate Laterals and Services

A. Accurate location of the lateral and service connections shall be made by inspection of the pre-installation videotape or sewer walk.

B. After the CIPP has been installed, all existing active lateral sewers and services shall be reinstated unless otherwise indicated by the OWNER or on the plans. The reinstatement of laterals and services shall be done without excavation unless otherwise specified by the OWNER. Reinstatement of laterals and services will be

accomplished from the interior of the CIPP by means of a video camera directed cutting device or by direct man entry when feasible.

C. All cut lateral and service connections shall be free of burrs, frayed edges, or any restriction preventing free flow of wastewater. Laterals shall be reinstated to a minimum of 90% of their original diameter and no more than 100% of their minimum diameter. The CIPP shall be tightly sealed at the cut openings with no gaps.

4.60.14 Quality Assurance Procedures

A. For every two thousand five hundred (2,500) lineal feet of CIPP installed, two (2) flat plate samples shall be processed and tested. For pipe diameters less than 18 inches, restrained end samples may also be utilized. The CIPP physical properties shall be tested in accordance with ASTM F1216, Section 8, using either allowed sampling method. The flexural properties must meet or exceed the values listed in Section 1.3.E of this specification and the values submitted to the OWNER by the Installation Contractor for this project's CIPP wall design, whichever is greater.

B. Testing shall be completed by an accredited, independent laboratory. Testing results shall be provided to the OWNER within seven (7) days of receipt.

C. Wall thickness of samples shall be determined in a manner consistent with paragraph 8.1.2 of ASTM D5813. The minimum wall thickness at any point shall not be less than 87.5% of the specified design thickness calculated in Section 1.3.F of this document.

D. Flexural testing of the collected samples shall be conducted in accordance with ASTM D790, latest version, with only the structural portion of the CIPP being tested.

E. CIPP installation shall be inspected by post-lining video inspection. Variations from true line and grade may be inherent because of the conditions of the original piping. No infiltration of groundwater should be observed. All service entrances should be unobstructed and accounted for.

4.60.15 Measurement and Payment

A. All work and material furnished under this section will be paid consistent with progress of the Work at the unit price per the Bid Form for Gravity Sewer Main Rehabilitation for the actual quantity of units installed as measured by the linear footage along the centerline of the pipe.

B. Payment for point repairs to facilitate inspection, cleaning or rehabilitation efforts will be paid at the established unit price for all sizes, all depths, and up to 10-feet lengths. Lengths beyond 10 feet will be paid as additional unit items as necessary.

4.61 – Cast-in-Place Manhole Rehabilitation Systems

4.61.1 Scope

It is the intent of this specification to provide for the reconstruction of deteriorated brick and concrete structures by the installation of a resin-impregnated flexible tube that is either inverted or set into the original structure and expanded to fit tightly against the outer walls by the use of water or air pressure. The resin system shall then be cured by elevating the temperature of the fluid (water/air) used for the inflation to a sufficient enough level for the initiators in the resin to effect a reaction. The finished structure shall be such that when the thermosetting resin cures, the total wall thickness shall be a homogeneous and monolithic felt and resin composite matrix, chemically resistant to withstand internal exposure to domestic sewage or stormwater.

Rehabilitation shall include reinforcement of structure walls, as necessary, and restoration of structure invert.

4.61.2 Qualifications

Since sewer products are intended to have a 50-year plus design life, and in order to minimize the OWNER's risk, only proven products with substantial successful installations and experience will be approved. In order for the CIP product and Installation Contractor to be deemed commercially acceptable and approved for this project, they must meet the following criteria:

A. CIP Product

a. The CIP product must have a minimum of two (2) million square feet of successful wastewater collection system installations in North America and must be documented to the satisfaction of the OWNER.

b. The CIPP product shall comply with the latest versions of ASTM F1216, as appropriate.

c. For the CIP to be considered Commercially Proven, it shall have been successfully in service in an application similar to this project for a minimum of 10 years and documented to the satisfaction of the OWNER.

d. The lining tube manufacturer shall operate under a quality management system that is third party certified to ISO 9001 or other internationally recognized organization standards. Proof of certification shall be submitted with the CONTRACTOR's bid and required for approval.

e. Third-party test results supporting the structural properties and long-term performance of the CIP product shall be submitted for approval, and such data shall be satisfactory to the OWNER. No CIP product will be approved without independent third party testing verification.

B. Installation Contractor

a. The Installation Contractor shall be certified by the CIP product manufacturer to have had at least 5 years active experience in the installation of the proposed CIP Manhole Rehabilitation product.

b. The Installation Contractor shall satisfy all insurance, financial and bonding requirements of the OWNER, and shall have installed within the United States a minimum of 1,000,000 square feet of the same CIP product being represented by the bidder.

c. The Installation Contractor superintendent(s) designated for the project shall have installed a minimum of 10,000 square feet and shall have 5 years of installation experience of the same CIP product being represented by the bidder. This shall be documented to the OWNER's satisfaction in the form of a resume of work experience detailing scope of work, location of work, and reference contact information for each project listed.

d. The Installation Contractor shall operate under a quality management system that is third party certified to ISO 9001 or equivalent standards. Proof of certification or quality management system shall be submitted with the CONTRACTOR's bid and required for approval.

4.61.3 Structural Requirements

A. Each CIP shall be designed to withstand internal and/or external loads as dictated by the site and structure conditions. Unless specified differently by the OWNER in the contract documents, the design thickness of the CIP shall be derived at using standard engineering methodology as found in ASTM F1216, Appendix X1. The long-term flexural modulus shall not exceed 50 percent of the short-term value for the CIP resin system and shall be substantiated through third-party testing. The thickness calculations, signed and sealed by a Professional Engineer, registered in the state of Texas, shall be submitted to the OWNER prior to CIP installation.

B. The layers of the finished CIP shall be uniformly bonded. It shall not be possible to separate any two layers with a probe or point of a knife blade so that the layers separate cleanly or such that the knife blade moves freely between the layers. If separation of the layers occurs during testing of the field samples, new samples will be cut from the work. Any reoccurrence may be cause for rejection of the work.

C. The Enhancement Factor 'K' to be used in the CIP design shall be assigned a value of 7.

D. Long-term testing in general accordance with ASTM D2990 must have been performed for flexural creep of the CIP material to be installed. Such testing results are to be used to determine the long-term, time dependent flexural modulus to be utilized in the product design. This is a performance test of the materials (CIP Tube and Resin) and general workmanship of the installation and curing as defined within the relevant ASTM standard. A percentage of the instantaneous flexural modulus value (as measured by ASTM D790 testing) will be used in design calculations for external buckling. The percentage, or the long-term creep retention value utilized, will be verified by this testing. The materials utilized for the contracted project shall be of a quality equal to or better than the materials used in the long-term test with respect to the initial flexural modulus used in the CIP design.

4.61.4 Materials

A. Manhole CIP rehabilitation system shall be Triplex Liner-6800 Series or OWNER approved equal.

B. CIP Tube

a. The CIP tube shall consist of one or more layers of a flexible needled felt or an equivalent nonwoven or woven material, or a combination of nonwoven and woven materials, capable of carrying resin, withstanding installation pressures and curing temperatures. The CIP tube should be compatible with the resin system to be used on this project. The material should be able to stretch to fit irregular structure sections.

b. The CIP tube should be fabricated under controlled conditions to a size that, when installed, will tightly fit the internal circumference and the depth of the original structure. The Installation Contractor shall verify the depths and sizes in the field before cutting the liner to length.

c. The CIP tube shall be uniform in thickness and when subjected to the installation pressures shall meet or exceed the designed wall thickness.

d. Any plastic film applied to the tube on what will become the interior wall of the finished CIPP shall be compatible with the resin system used, translucent enough that the resin is clearly visible, and shall be firmly bonded to the felt material.

e. At time of manufacture, each lot of CIP tube shall be inspected and certified to be free of defects. The tube shall be marked for distance at regular intervals along its entire length, not to exceed five feet. Such markings shall also include the CIP tube Manufacturer's name or identifying symbol.

C. Resin Components

a. The resin system shall be a corrosion resistant polyester or vinylester, along with a compatible catalyst system.

b. The resin used shall not contain non-strength enhancing fillers.

c. When combined with the CIP tube, the resin system shall provide a CIP that meets the structural requirements of ASTM F1216 or ASTM F1743, the minimum physical properties specified, and those properties which are to be utilized in the design of the lining system for this project.

d. When combined with the CIP tube, the resin system shall provide a CIP that complies with the chemical resistance requirements specified in ASTM F1216 or ASTM F1743.

4.61.5 Storage and Handling

A. The Installation Contractor shall deliver the resin impregnated CIP tube to the site and provide all equipment required to insert and cure the CIP within the host pipe. The Installation Contractor shall designate a location where the tube will be vacuum impregnated with the resin prior to installation. If requested by the OWNER, the Installation Contractor shall notify the OWNER at least 48 hours prior to wet out to allow the OWNER's representative to observe the materials and wet out procedure. All procedures to prepare the CIP for installation shall be in strict accordance with the Manufacturer's recommendations.

B. The CIP shall be vacuum impregnated with resin not more than 120 hours before the time of installation and stored out of direct sunlight at a temperature of less than 70° F.

4.61.6 Notification and Preparation

A. The Installation Contractor shall notify all residents affected by this construction at least 24 hours prior to any service disruption affecting their service connection. The Installation Contractor shall make every effort to maintain service usage throughout the duration of the project.

B. The Installation Contractor shall perform cleaning, video, and inspection prior to installation of the CIP. The Installation Contractor, when required, shall remove all debris from within the structure that will interfere with the installation of the CIP. The CONTRACTOR shall provide a dumpsite for such debris removed during the cleaning operations.

C. It shall be the responsibility of the Installation Contractor to notify the OWNER of line obstructions or collapsed structures that will prevent the insertion of the tube or significantly reduce the integrity of the structure. The OWNER, with input from the Installation Contractor shall determine the method of structural repair required and shall address these concerns on a case-by-case basis.

D. Protruding laterals or services shall be trimmed flush with the inside of the structure wall prior to installation of the CIP. Trimming shall not cause damage to the lateral or service beyond the inside face of the structure.

4.61.7 Bypass Pumping

A. The CONTRACTOR, when required, shall provide for the flow of sewage around the structure or structures designated for repair. When possible, the bypass shall be made by plugging the line at an existing upstream manhole and pumping the flow into a downstream manhole or adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle the flow. The CONTRACTOR shall furnish all necessary pumping equipment, conduit, etc. to adequately, safely, and environmentally divert sewage flow around the work.

B. CONTRACTOR shall prepare and submit a bypass pumping plan (BPP) for each phase of construction. Implementation and maintenance of bypass pumping operations shall be the responsibility of the CONTRACTOR throughout construction.

4.61.8 Photo Inspection

A. The Installation Contractor shall provide photographic documentation of the conditions as found within the structure. Lighting for the camera shall illuminate the entire periphery of the structure.

B. Both a pre-lining and post-lining photograph library or video shall be submitted to the OWNER for approval. The discs shall be clearly and properly labeled.

4.61.9 Installation

A. The CIP shall be installed in accordance with the practices given in ASTM F1216 (for direct inversion installations), as appropriate. The quantity of resin used for the tube's impregnation shall be sufficient to fill the volume of air voids in the CIP tube with additional allowances being made for polymerization shrinkage and the loss of

any resin through cracks and irregularities in the original structure. A vacuum impregnation process shall be used in conjunction with a roller system to achieve a uniform distribution of the resin throughout the CIP tube.

B. The resin-impregnated CIP tube shall be installed into the host pipe by methods specified in ASTM F1216 or ASTM F1743 and proven through previous successful installations. The insertion method shall not cause abrasion or scuffing of the CIP tube. Hydrostatic or air pressure shall be used to inflate the CIP tube and mold it against the walls of the host pipe. There will be no use of sewage in place of clean water for insertion of the tube, or for the curing of the liner.

C. Temperature gauges shall be used to monitor the temperatures during the cure cycle.

4.61.10 Curing

A. After the CIP tube installation is completed, the Installation Contractor shall supply a suitable heat source and recirculation equipment (if required). The equipment shall be capable of delivering hot water or steam throughout the section to uniformly raise the temperature above the temperature required to affect a cure of the resin.

B. The heat source shall be fitted with suitable monitors to gauge the temperature of the incoming and outgoing heat supply (for water cure) and outgoing heat supply (for steam cure). Water or air temperature in the structure during the cure period shall be as recommended by the resin Manufacturer.

C. Initial cure shall be deemed to be completed when inspection of the exposed portions of the CIP appears to be hard and sound and the remote temperature sensor(s) indicates that the temperature is of a magnitude to realize an exotherm. The cure period shall be of a duration recommended by the resin Manufacturer, as modified for the installation process, during which time the recirculation of the heat and/or cycling of the heat exchanger to maintain the temperature is continued.

4.61.11 Cool Down

A. Cool down may be accomplished by the introduction of cool water or air to replace water or pressurized air being relieved. Care shall be taken in the release of the hydrostatic head so that a vacuum will not be developed.

4.61.12 Finish

A. The finished CIP shall be continuous over the entire structure and be as free as commercially practical from visual defects such as foreign inclusions, dry spots, pinholes, and delamination. The CIP shall be homogeneous, and free of any leakage from the surrounding ground to the inside of the structure

B. Where the CIP is installed in a manhole, the invert shall be maintained smooth within the manhole. The invert of the manhole shall be shaped and grouted as necessary to complement the liner. The cost of this work shall be included in the CIP unit price.

C. During the warranty period, any defects which will affect the integrity or strength of the CIP, collect solids, or reduce hydraulic flow capabilities of the product shall be repaired at the Installation Contractor's expense in a manner mutually agreed upon by the OWNER and the Installation Contractor.

4.61.13 Reinstate Laterals and Services

A. Accurate location of the lateral and service connections shall be made by inspection of the structures.

B. After the CIP has been installed, all existing active lateral sewers and services shall be reinstated unless otherwise indicated by the OWNER or on the plans. The reinstatement of laterals and services shall be done without excavation unless otherwise specified by the OWNER. Reinstatement of laterals and services will be accomplished from the interior of the structure by means of a cutting device.

C. All cut lateral and service connections shall be free of burrs, frayed edges, or any restriction preventing free flow of wastewater. Laterals shall be reinstated to a minimum of 90% of their original diameter and no more than 100% of their minimum diameter. The CIP shall be tightly sealed at the cut openings with no gaps.

4.61.14 Quality Assurance Procedures

A. For every five hundred (500) square feet of CIP installed, two (2) flat plate samples shall be processed and tested. The CIP physical properties shall be tested in accordance with ASTM F1216, using either allowed sampling method. The flexural properties must meet or exceed the values listed in Section 1.3.E of this specification and the values submitted to the OWNER by the Installation Contractor for this project's CIP wall design, whichever is greater.

B. Testing shall be completed by an accredited, independent laboratory. Testing results shall be provided to the OWNER within seven (7) days of receipt.

C. Wall thickness of samples shall be determined in a manner consistent with ASTM D5813. The minimum wall thickness at any point shall not be less than 87.5% of the specified design thickness specified.

D. Flexural testing of the collected samples shall be conducted in accordance with ASTM D790, latest version, with only the structural portion of the CIP being tested.

E. CIP installation shall be inspected post-lining. Variations from true line and grade may be inherent because of the conditions of the original structure. No infiltration of groundwater should be observed. All service entrances should be unobstructed and accounted for.

4.61.15 Measurement and Payment

A. All work and material furnished under this section will be paid consistent with progress of the Work at the unit price per the Bid Form for Manhole Rehabilitation for the actual quantity and depth of units installed as measured from the manhole rim elevation to the manhole invert elevation per each.

4.65– Electromagnetic Flow Meter

4.65.1 General

Flow meter shall operate on electromagnetic induction principle and give an output signal directly proportional to the velocity of the medium being measured.

4.65.2 Primary Flow Head

The primary flow head shall have a stainless-steel metering tube and a nonconductive liner suitable for the liquid being metered.

Housing shall be epoxy coated steel, welded at all joints. Bolted coil enclosures shall not be acceptable. The field coils of the meter shall be supplied with a precisely adjusted bi-polar direct current.

There shall be no electronic components on the primary flow head. A remote converter shall supply coil drive power. Output signal from the primary shall be fed through 'DS' or 'BTS' proprietary cable supplied with the meter to the signal converter.

The Primary flow head shall have a housing rated weatherproof NEMA 4X and NEMA 6 IP67 and be provided with optional complete submergence, IP68.

Electrodes shall be field replaceable with access ports and compatible with medium being metered.

End connections shall be steel flanged, ANSI Class 150.
Liner material will be Hard Rubber or Polyurethane.

When installed in lined or non-metallic piping, the meter shall be provided with corrosion resistant grounding rings. Grounding electrodes shall not be acceptable.

Meter calibration shall be performed by a direct volumetric comparison method with a minimum of 3 points tested. A calibration certificate shall accompany each meter.

The meter shall be manufactured in an ISO 9001 approved facility. Flow meter shall be KROHNE, Inc. ENVIROMAG series.

4.65.3 Magnetic Inductive Flow Converter

The magnetic inductive flow converter shall be integral or remote mounted and provide precisely controlled and regulated, bi-polar DC primary field excitation pulses which are digitally selectable at 12 different frequencies. The unit shall convert the primary flow meter signal into a standard linear analog or pulse/frequency output directly proportional to the flow rate or flow total. The accuracy of the converter shall be .2% +/- 1mm of measured value. The converter shall have empty pipe indication/stabilization standard. The Converter shall be capable of **Virtual Reference**, negating the need for grounding rings/electrodes in processes with conductivity greater than 200 micromho's.

The converter shall be capable of up to (4) inputs or outputs with selectable combinations of:

Standard 4-20 mA DC with HART
Totalized pulses.
Frequency output of 0 – 10 kHz

Control Input
Alarm/Status Output

The full scale measuring range shall be a configurable input in all standard engineering units as well as any user defined unit, and freely adjustable over a range from 1.0 to 40 ft/sec velocity.

Converter shall be capable of continuously monitoring all common modes of failure of magnetic inductive flow meters, verifying a100% check of flow meter software and hardware components, 100% check of accuracy and linearity, and 100% check of process conditions that may adversely affect flow measurement uncertainty. The converter shall provide local display of detected errors, as well as the ability to assign any or all errors to outputs. All diagnostics shall be available on the standard HART communication protocol, PACTware or other bus protocol as specified.

The converter shall be microprocessor based and be completely interchangeable with other converters of the same type. The converter housing shall contain an EEPROM memory, saving the original calibration data, factory default configuration settings, and (2) user defined configuration setting profiles, which can be uploaded to temporarily test configuration changes or re-configure replaced electronics. No auxiliary test meter or primary simulator shall be required for commissioning, zeroing, or interchanging of the flow converter. The converter shall have two independent counters, which are assignable as Positive, Negative or Sum totals. Counters shall be password protected to prevent unauthorized resetting. The counters shall maintain their accumulated values with power loss, and continue counting when power resumes. The converter shall be provided with local graphical display (back-lit white), 128 x 64 pixels with three separate display pages; pages 1 and 2 shall allow viewing from 1 to 3 lines of measured values (user assignable) in engineering units or with 0-100% bar graph. User selectable measurements (i.e. flow rate, counter 1 and/or 2 (+, -, or sum), diagnostics, etc.) on either display page and display line. Display page 3 shall show all diagnostics that are currently active or occurred since last acknowledgement. The top line of the display shall show the meter Tag Number as configured into the unit, as well as a graphical indication of errors detected.

Programming of the flow converter shall be accomplished without removing the glass cover via 4 optical keys or remotely with hand held HART terminal or with vendor and protocol independent PC configuration software; PACTware (**P**rocess **A**utomation **C**onfiguration **T**ool) over HART or other bus protocols. Manufacturer shall provide necessary drivers (DTM's) at no additional charge.

Analog outputs shall have user configurable time constant of 0 to 100 seconds.

User adjustable low flow cutoff to force readings to zero on decreasing flow and de-activate on increasing flow, settable from 0% to 20% of full scale setting, with the decreasing flow setting < increasing flow setting (providing hysteresis).

The converters basic input and output shall contain four I/O's;

(1) Analog mA output
(1) Pulse or Analog Frequency output
(2) Status outputs.

The basic outputs can be altered in the field by programming. All inputs / outputs shall be galvanically isolated from each other and all other circuits.

The analog outputs can be assigned to represent any of the following measurements; Flow Velocity, Volume Flow Rate, Mass Flow Rate, Coil Temperature (indicative of process temperature), or Process Conductivity.

The converter shall have HART smart protocol as standard.

Optionally the converter shall have Foundation Fieldbus or Profibus PA or DP protocols as required.

The converter shall provide the ability to simulate flow rates, to verify analog output spans are correct in receiving devices. The converter shall self-test for over load or open circuits on the analog output and alarm if either condition exists.

The converter shall provide the capability to test all inputs and outputs for proper operation to assist in commissioning.

The converter shall self-test all variables that can affect magnetic inductive flow meters performance, and verify all variables are within tolerance, and alarm when measurements are uncertain, without the use of additional test equipment.

Ten year data retention during storage, without the need for auxiliary power.

FM Approved for Class 1 Div 2.

The signal converter shall be manufactured in an ISO 9001 approved facility.

Magnetic Inductive Flow Converter shall be a KROHNE model OPTIFLUX IFC300.

4.65.4 Measurement and Payment

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

4.70 – Wastewater Lift Station

4.70.1 General

This section covers the furnishing and installation of a wastewater lift station with electric submersible pumps, to be supplied with integral electric motor, discharge elbow, guide rail assemblies, redundant level control system, pump control panel, all necessary installation accessories and appurtenances, training and start-up to construct a complete and functional sewage lift station as specified.

4.70.2 Submittals

A. Product Data:

1. Submit product data for approval for each size pump. As a minimum, include the following:

   a. Complete assembly, foundation support, and installation drawings, together with detailed specifications and data covering pumps, motors, material used, parts, devices and other accessories forming a part of the equipment furnished shall be submitted for approval in accordance with the procedure set forth in the General Conditions.

   b. Setting plans. Setting plans shall include:

      i. Anchor bolt layout.

      ii. Anchor bolt dimensions.

      iii. Outline dimensions and weights of pumps, bases, motors, and control enclosures.

   c. Pumps. Data and drawings shall include:

      i. Manufacturer, type and model number.

      ii. Assembly drawings, nomenclature and material lists, O & M manual, parts lists, descriptive literature, bulletins, and technical manuals.

      iii. Type, manufacturer, model numbers, location and spacing of bearings.

      iv. Impeller type, diameter, through-let dimensions, sphere size, number of vanes and identification number.

      v. Complete motor performance data including: rating, voltage/phase/frequency; design type; service factor; insulation class; motor pole number; actual rotation speed when combined with the specified pumps; current, power factor and active input power (KW) as a continuous function of shaft power from no load to at least 115 percent load; start (max. inrush) current; locked rotor current; NEC code letter; and motor torque as a continuous function through the motor start cycle from no rotation to synchronous speed.

vi. Complete performance test curve(s) showing full range (shutoff to run-out) head vs. capacity, NPSHR, hydraulic efficiency, motor active (KW) input power, motor total (KVA) input power (based on measured current and voltage), and shaft power (BHP).

vii. Cables required for motor.

viii. Location and description of Service Centers and spare parts stock.

ix. Warranty for the proposed equipment.

d. The manufacturer shall indicate, by arrows to points on the Q/H curves, limits recommended for stable operation, between which the pumps are to be operated to prevent surging, cavitation, and vibration. The stable operating range shall be as large as possible, and shall be based on actual hydraulic and mechanical characteristics of the units and shall meet the hydraulic performance requirements of the proposed system.

2. Schedule of Values:

a. Submit individual schedule of values for each lift station to assist in partial payment estimating of work completed to date.

4.70.3 Performance Requirements

Pump performance characteristics shall be such as to ensure stable operation and steady flow through the range of operating conditions when pumping raw, unscreened domestic sewage and wastewater. See Pump Schedule for specific performance requirements for the lift station(s).

All pumps shall be non-clog design, capable of passing an incompressible sphere of three (3) inches or greater in diameter.

Pumps shall be suitable for continuous operation underwater without loss of watertight integrity to a depth of 65 feet.

The pumps shall be suitable for pumping raw sewage and shall be designed and fully guaranteed for this use. The maximum continuous temperature of the pumped liquid shall be 104°F.

Each pump shall be given a certified non-witnessed performance test to prove compliance to the performance data above. Test curves shall be submitted to the Engineer for approval prior to shipment.

4.70.4 Testing Requirements

A. General

1. Equipment shall be shop tested and field tested as specified hereinafter. All costs for the tests shall be borne by the CONTRACTOR. The CONTRACTOR shall submit the complete shop test procedures to the Engineer for approval at least 30 days prior to the shop test. In the event any equipment fails to meet the performance values set forth in this specification, the equipment shall be

modified and re-tested or replaced with equipment that performs in accordance with this specification.

B. Shop Tests

1. Pumps and Motors

a. Each pump and motor shall be performance tested as specified hereinafter; all pumps shall be tested with motor cables to be supplied with the pumps. Three copies of certified test reports, including actual test records, shall be submitted and approved by the Engineer prior to shipment of the equipment.

b. The CONTRACTOR shall submit the complete pump test procedure, a diagram of the test setup showing location of instruments, a sample of the test stand log sheet, and calibration data of all instruments and measuring devices to be used by the manufacturer to the Engineer, for approval, prior to the pump tests.

c. Each pump shall be tested for performance at the factory to determine the head vs. capacity, motor total electrical power draw (KVA), and motor active electrical power draw (KW) for the full speed at which the pumps are specified and shown on a performance test curve, certified by a registered professional engineer, as continuous functions throughout the pump's performance range. Tests of models, prototypes or similar units will not be acceptable.

d. All tests shall be run in accordance with the test code for centrifugal pumps of the Standards of Hydraulic Institute, latest edition. The motor and cable on each pump shall be tested for moisture content or insulation defects. After the test, the pump cable end shall be fitted with a shrink-fit rubber boot to protect it from moisture or water.

C. Field Tests

1. Equipment shall be field tested as specified hereinafter. Field testing shall be composed of preliminary tests and acceptance tests. The CONTRACTOR shall provide the services of authorized equipment supplier's representatives to conduct all field tests.

D. Preliminary Tests

1. Preliminary tests shall be run on all pumps, motors, and control systems to demonstrate that they are in proper working order.

E. Acceptance tests

1. Acceptance tests shall be run to demonstrate that the pumping units, motors and control system meet the following requirements:

a. The pumping units operate as specified without excessive noise, cavitation, vibration, and without overheating of the bearings.

b. All automatic and manual controls function in accordance with the specified requirements.

c. All drive equipment operates without being overloaded.

4.70.5 Service and Warranty

The pump manufacturer shall have an authorized factory service center capable of completely servicing the proposed pumps within 250 miles of the project site.

All equipment shall be guaranteed against defects in material and workmanship for a period of one year from date of OWNER's final inspection and acceptance to the effect that any defective equipment shall be repaired or replaced without cost or obligation to the OWNER.

The pump manufacturer shall warranty the pump units supplied to the OWNER against defects in material and workmanship for a period of at least five (5) years or 10,000 operating hours in writing under the operating conditions presented by this project. Pump manufacturer shall demonstrate ability to support claimed warranty coverage of this specification.

4.70.6 Schedule

A. See following Table 1.5 for pump schedule.

TABLE 1.5
PUMP SCHEDULE

	Main Lift Station
Number of Pumps	2 (duplex set-up)
Type of Pump	non-clog submersible
Primary Design Point (min. capacity, GPM each pump)	600 (+/- 10%)
Primary Design Point (min. TDH, feet)	45
Primary Power	460 V, 60 Hz, 3 phase
Motor Horsepower (max)	12
Pump Speed (nominal RPM)	1,750
Pump Discharge Size (inches)	4
Station Discharge Piping Size (inches)	6
Force Main Size (inches)	10

4.70.7 Acceptable Pump Manufacturers

4" Flygt NP 3153 HT 466.

The specifications and project drawings depict equipment and materials manufactured by the accepted suppliers which are deemed most suitable for the service anticipated. It is not intended, however, to eliminate other products of equal quality and performance. The CONTRACTOR shall prepare his bid based on the specified equipment for purposes of determining low bid. Award of a contract shall constitute an obligation to furnish the specified equipment and materials.

In event the CONTRACTOR desires to submit an equipment substitution, the CONTRACTOR shall submit requested substitution to the OWNER a minimum of 10 days prior to bid closing. If the proposed substitution requires any resulting changes to the enclosures, buildings, piping or electrical systems to accommodate the proposed equipment, the CONTRACTOR shall do so at his own expense. Revised detail drawings illustrating the substituted equipment shall be submitted to the OWNER prior to acceptance. If accepted, the cost difference of the proposed substitution shall be reflected in the unit bid.

Proposed alternates will be evaluated by the OWNER for cost effectiveness, acceptability for the application, maintenance considerations and compliance with the Contract Documents. If a proposed substitution is determined to be acceptable for the project, the OWNER will notify bidders through an Addendum to the bid documents.

If the OWNER accepts an equipment substitution, it does not relieve the CONTRACTOR from his/her responsibility for full compliance with the contract documents.

4.70.8 Submersible Non-Clog Sewage Pumps

Pump Design (Wet Well Mounted): The pump shall be capable of handling raw, unscreened sewage. The discharge elbow shall be permanently installed in the wet well along with the discharge piping. The pumps shall be automatically connected to the discharge connection elbow when lowered into place. Pumps shall be easily removable for inspection or service, requiring no bolts, nuts or other fastenings to be removed for the purpose and no need for personnel to enter the pump well. Sealing of the pumping unit to the discharge elbow shall be accomplished by a simple linear downward motion of the pumps with the entire weight of the pumping units guided to and pressed tightly against the discharge elbow with a field replaceable Nitrile (BUNA-N) profile gasket or o-ring to accomplish positive sealing. No portion of the pump shall bear directly on the floor of the sump, and there shall be no more than one 90 degree bend allowed between the volute discharge flange and sump piping. Guide bars, which shall steer the pump into proper contact with the discharge elbow shall be non-adjustable and shall not bear the weight of the pump.

A. Pump Construction

1. Major pump components shall be of gray cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other casting irregularities. Higher density cast irons (Class 40 and above) with reduced vibration damping capacity, will not be acceptable for pump driver castings, such as stator and bearing housings. All exposed nuts or bolts shall be AISI type 316 stainless steel. All metal surfaces coming into contact with the pumped media, other than stainless steel and/or brass, shall be protected by a factory-applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.

2. Sealing design shall incorporate metal-to-metal contact between machined surfaces. Pump/Motor unit mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton Rubber O-rings. Joint sealing will be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific bolt torque limit.

3. Rectangular cross sectioned gaskets that require specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds, elliptical O-rings, grease or other devices shall be used.

B. Cable Entry

1. The cable entry seal design shall provide strain relief and preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of at least one elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the cable entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable. The assembly shall provide ease of changing the cable when necessary using the same entry seal. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

2. The junction chamber shall be isolated and sealed from the motor by means of sealing glands. Electrical connections between the power cables and motor leads shall be made via a compression or post type terminal board, allowing for easy disconnection and maintenance.

C. Motor Cooling System

1. General - Each unit shall be provided with an adequately designed integral cooling system that allows up to 12 motor starts per hour with a non submerged motor on a continuous basis in an ambient 104 degree F environment, and in a standard available version, with no damage to motor windings, bearings, or drive shaft seals. The pump supplied under this specification shall be suitable for continuous operation; under submerged, partially submerged or dry conditions. Without de-rating the motor, the pump shall be able to pump continuously with the motor exposed (the water level at the top of the volute) and under full load, without the need of spray systems or air moving equipment with an ambient temperature of 104 degrees F (40^{O}C). The motor shall not be rated at 30^{O}C. Cooling system shall be a Static System (using the exterior of the stator housing for radiant heat dissipation), or Re-circulated Coolant System (using a re-circulated coolant). Fans, blowers, or auxiliary external cooling systems are not acceptable.

2. Re-circulated Coolant Systems – A motor cooling jacket shall encircle the stator housing, providing for dissipation of motor heat, regardless of the type of pump installation. An impeller, integral to the closed-loop cooling system and driven by the pump shaft, shall provide the necessary circulation of the cooling liquid through the jacket. The coolant circulation passages should be sized to provide enhanced heat transfer from stator housing to coolant through insured turbulent flow of coolant as it passes the stator housing. The cooling system shall incorporate one fill port and one drain port in the cooling jacket.

3. Thermal Protection: Each phase of the motor shall contain a normally closed bi-metallic temperature monitor switch imbedded in the motor windings. These thermal switches shall be connected in series and set to open at 140_C _ 5_C (284_F). They shall be connected to the control panel to provide a high stator temperature shutdown signal, and are used in conjunction with external motor overload protection.

D. Mechanical Shaft Seal System

1. Mechanical Seals:

a. Each pump shall be equipped with a triple seal system consisting of tandem mechanical shaft seals, plus a radial lip seal; providing three complete levels of sealing between the pump wet end and the motor. The mechanical seal system shall consist of two totally independent seal assemblies operating in a lubricant reservoir that hydro-dynamically lubricates the lapped seal faces at a constant rate. The mechanical seals shall be of non proprietary design, and shall be manufactured by a major independent manufacture specializing in the design and manufacture of mechanical seals. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain on stationary industrial duty solid silicon-carbide seal ring and one rotating industrial duty solid silicon-carbide seal ring. The stationary ring of the primary seal shall be installed in a seal holding plate of gray cast iron EN-GJL-250 (ASTM A-48, Class 35B). The seal holding plate shall be equipped with swirl disruption ribs to prevent abrasive material from prematurely wearing the seal plate. The upper, secondary seal unit, located between the lubricant chamber and the sensing chamber, shall contain one stationary industrial duty solid silicon-carbide seal ring, and one rotating one rotating industrial duty solid silicon-carbide seal ring.

b. Each seal interface shall be held in contact by its own spring system. A radial lip seal shall be positioned above the sensing chamber, preventing any liquid which accumulates in the sensing chamber from entering the lower bearing and motor. The seals shall not require routine maintenance, or adjustment, and shall not be dependent on the direction of rotation for proper sealing. Each pump shall be provided with a lubricant chamber for the shaft sealing system which shall provide superior heat transfer and maximum seal cooling. The lubricant chamber shall be designed to prevent overfilling, and to provide lubricant expansion capacity. The drain and inspection plug shall have a positive anti-leak seal, and shall be easily accessible from the outside of the pump. The seal system shall not rely upon the pumped media for lubrication and shall not be damaged when the pump is run dry. Lubricant in the chamber shall be environmentally safe non toxic material.

c. The following seal types shall not be considered equal: Seal systems with less than three complete levels of sealing between the pump wet end of the motor. Seals of proprietary design, or seals manufactured by other than major independent seal manufactured companies. Seals requiring set screws, pins, or other mechanical locking devices to hold the seal in place, conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces, any system requiring a pressure differential to seat the seal and ensure sealing.

E. Impeller

1. The impeller shall be of Hard-Iron™ (ASTM A-532 (Alloy III A) 25% chrome cast iron), dynamically balanced, semi-open, multi-vane, back swept, screw-shaped, non-clog design. The impeller leading edges shall be mechanically self-cleaned automatically upon each rotation as they pass across a spiral groove located on

the volute suction. The leading edges of the impeller shall be hardened to Rc 60 and shall be capable of handling solids, fibrous materials, heavy sludge and other matter normally found in wastewater. The screw shape of the impeller inlet shall provide an inducing effect for the handling of up to 5% sludge and rag-laden wastewater. The impeller to volute clearance shall be readily adjustable by the means of a single trim screw. The impeller shall be locked to the shaft, held by an impeller bolt and shall be coated with alkyd resin primer.

F. Bearings

1. Each pump shaft shall rotate on high quality permanently lubricated, greased bearings. The upper motor bearing shall be a two row angular contact ball bearing. The lower bearing shall be a two row angular contact ball bearing to handle the thrust and radial forces. The minimum L10 bearing life shall be 50,000 hours at any usable portion of the pump curve. Bearings shall be of sufficient size and properly spaced to transfer all radial and axial loads to the pump housing and minimize shaft deflection.

G. Motor

1. Each pump shall be driven by a vertical, submersible squirrel cage induction motor, shell type NEMA B design, housed in a dry watertight chamber. The motor and the pump shall be produced by the same manufacturer.

2. The stator winding shall be insulated with moisture resistant Class H insulation, rated for a temperature of 180-C. The stator shall be press fitted into the stator housing. The rotor bars and short circuit rings shall be made of cast aluminum. The use of bolts, pins, screws, or other fastening devices used to locate or hold the stator and that penetrate the stator housing shall be rejected. The motor shall be designed for continuous duty, while handling pumped media of up to 104 degrees F. The motor shall be capable of withstanding at least 12 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of aluminum.

3. The motor service factor (as defined by NEMA MG Standards) shall be 1.3. The motor shall have a voltage tolerance of plus or minus 10%. The motor shall be designed for continuous operation in a 40^{o}C. ambient environment and shall have a NEMA Class A maximum operating temperature rise. A motor performance curve shall be provided upon request, showing torque as a function of speed, and current, power factor, speed, input power in KW, and efficiency as a function of shaft power.

4. Shaft.

   a. The pump shaft and motor shaft be an integral, one piece unit adequately designed to meet the maximum torque required at any normal start-up condition or operating point in the system. The shaft shall have a full shutoff head design safety factor of 1.7, and the maximum shaft deflection shall not exceed (002 inch) at the lower seal during normal pump operation. Each shaft shall be stainless steel (AISI 420) material, and shall have a polished finish with accurately machined shoulders to accommodate bearings, seals and impeller.

5. Motor Cables.

    a. Pump motor power cables installed shall be oil, water and UV resistant, suitable for submersible pump applications and heavy mechanical stresses. The power cable shall also be sized according to NEC and CSA standards and also have P-MSHA approval. The total length of each cable shall be a minimum of 49 feet long. Power cables shall each include a ground check conductor.

H. Explosion-proof Service

1. The pump system and appurtenances, including the pump, motor, and wiring, shall be approved by a national approved testing agency for installation in the State of Texas for explosion proof service. The system shall be rated for Class 1, Division 1, Group C and D service as determined by the National Electrical Code (NEC) and approved by a nationally recognized testing agency (U.L., F.M., or CSA) at the time of bidding this project.

4.70.9 Pump Control Panel

Reference Control Panel Specification.

4.70.10 Guide Rails and Brackets

A. Design shall be double guide rail systems and utilize Schedule 40, 316 stainless steel guide rail for each pump sized to mount direct to the quick discharge connector at the floor of the wet well and to a guide bracket at the top of the wetwell below the hatch opening (refer to Drawings).

1. The guide bars shall guide the pump unit in raising and lowering. The guide bars shall not support any portion of the weight of the pump. The lower guide bar holders shall be integral with the discharge elbow. Guide cables shall not be considered equal to guide bars and will not be accepted. The pump unit shall be guided on the bars by a guide bracket which shall be an integral part of the pump.

2. The pump guide bracket and discharge elbow shall be constructed of cast ductile iron with mounting feet and 150 lb. flange. An upper guide rail mounting bracket and sufficient intermediate guide rail brackets shall be supplied and installed within the wetwell such that the maximum unsupported rail length is eight (8) feet or less.

4.70.11 Lifting Cable and Fitting

Each pump shall be fitted with two (2) feet of AISI 316 stainless steel lifting chain, with necessary fittings, capable of lifting 150% of full weight of the pump and motor assembly, with thirty (30) feet of premium-quality one (1) inch Nylon secured to the lifting chain.

Provisions shall exist for the Nylon rope to be coiled and hung from the top of the guide rail so it can be accessed without entering the wetwell and uncoiled for use. Include a safety mechanism so the rope cannot be dropped into the wetwell.

4.70.12 Fasteners

All fasteners within the wet well shall be constructed of 316 stainless steel.

4.70.13 Pump Hoisting Equipment

This lift station will NOT include a portable davit crane as OWNER maintenance vehicles are equipped with Jib cranes for lifting station equipment.

4.70.14 Paints and Coatings

Provide manufacturers standard coating system for pump and motor suitable for continuous submerged service in raw sewage.

4.70.15 Installation

Install the equipment as indicated and in accordance with the manufacturer's written instructions.

All conduits exiting the wetwell shall be sealed in accordance with the National Electrical Code to prevent gases, including hydrogen sulfide gas, from entering electrical boxes.

The pump control panel shall be installed as indicated on the plans.

The CONTRACTOR shall be responsible for all material furnished by him and he shall replace, at his own expense, all material that is found to be defective in manufacture. The CONTRACTOR shall also be responsible for all material that has become damaged during delivery, handling, installation or start-up. Protect all equipment after installation until final acceptance by OWNER.

4.70.16 Field Testing, Training and Startup

The services of a factory-trained and fully-qualified representative shall be provided to inspect the completed installation, make all adjustment necessary to place the system in trouble-free operation and instruct the operating personnel in the proper operation, care and maintenance of the equipment. Training shall be at least four (4) hours. Visit to be after water is available and pumps can be operated for extended periods.

Test and demonstrate proper operation of system by simulating inflow with a temporary source of water.

Starting at shut off, record the flow, head, amps, power factor and input kW at a minimum of six (6) equally spaced points. Run one point at or near the design duty point.

Set pump control to occur at the various wet well levels indicated on the Plans and demonstrate pump operation at each level.

Fill basin and allow pump to cycle several times. Then shut off pump and allow basin to fill to trip the high water alarm. Demonstrate that all normal operations and alarm functions of the installed station work as designed and intended.

Measure motor current and voltage during testing and submit readings to the OWNER.

Factory approved service facilities with qualified factory trained mechanics shall be located within 60 miles of installation and be available for prompt emergency and routine service. A local stock of spare parts shall also be available at this service facility.

The pump supplier shall have a local service facility authorized by the pump manufacturer. The pump supplier shall include in the pump cost routine maintenance on

the pumps for the first year of service. This shall include lubrication, mechanical seal maintenance, and operational checks to included pressure gauge readings, amp readings, and temperature readings. A maintenance log with each service call shall be kept by the serviceman and a completed log shall be given to the City after the one year of operation is complete. A certificate of Authenticity from Pump Manufacturer shall be included with the submittal data for approval stating the name and location of the local authorized service center. This service center must be located within 250 miles of the installation. Submittals for approval without this documentation will be immediately returned without further review.

4.70.17 Fencing

Lift Station site fencing shall be 8' tall, 8" CMU split-faced block, with up to two colors. Steel posts shall be prepared, primed and painted in accordance with industry standards. CONTRACTOR shall coordinate colors with OWNER.

4.70.18 Measurement and Payment

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

4.71 – Odor Control Systems

4.71.1 General

This section covers the furnishing and installation of odor control systems on wastewater lift stations, force mains or gravity mains and all necessary installation accessories and appurtenances, training and start-up to construct a complete and functional odor control system as specified.

4.71.2 Submittals

A. Product Data:

1. Submit product data for approval for each size pump. As a minimum, include the following:

   a. Complete assembly, foundation support, and installation drawings, together with detailed specifications and data covering pumps, blowers, motors, material used, parts, devices and other accessories forming a part of the equipment furnished shall be submitted for approval in accordance with the procedure set forth in the General Conditions.

   b. Setting plans. Setting plans shall include:

      i. Anchor bolt layout.

      ii. Anchor bolt dimensions.

2. Control Panel:

   a. Control panel equipment and material, including a bill of material and manufacturer's data on each item.

   b. Electrical wiring diagram of the control panel.

   c. Panel layout.

   d. Electrical schematics.

   e. Float switches.

3. Schedule of Values:

   a. Submit individual schedule of values for each system to assist in partial payment estimating of work completed to date.

4.71.3 Performance Requirements

System performance characteristics shall be such as to ensure stable operation and steady flow through the range of operating conditions when treating odor generated from raw wastewater.

Odor Control Systems shall remove 99% of Hydrogen Sulfide concentrations in air stream, as well as other odor generating compounds found in typical municipal wastewater streams.

Odor Control System shall operate without chemical or nutrient addition following startup.

System shall draw air through the media using negative vacuum pressure.

System shall not require temperature or humidification control of the air stream.

System shall be capable of operating in all weather conditions, including insulation of all exposed water supply pipes.

4.71.4 Testing Requirements

A. General

1. Equipment shall be shop tested and field tested as specified hereinafter. All costs for the tests shall be borne by the CONTRACTOR. The CONTRACTOR shall submit the complete shop test procedures to the OWNER for approval at least 30 days prior to the shop test. In the event any equipment fails to meet the performance values set forth in this specification, the equipment shall be modified and re-tested or replaced with equipment that performs in accordance with this specification.

B. Field Tests

1. Equipment shall be field tested as specified hereinafter. Field testing shall be composed of preliminary tests and acceptance tests. The CONTRACTOR shall provide the services of authorized equipment supplier's representatives to conduct all field tests.

C. Preliminary Tests

1. Preliminary tests shall be run on all pumps, motors, and control systems to demonstrate that they are in proper working order.

D. Acceptance tests

1. Acceptance tests shall be run to demonstrate that the pumping units, motors and control system meet the following requirements:

   a. The pumping units operate as specified without excessive noise, cavitation, vibration, and without overheating of the bearings.

   b. All automatic and manual controls function in accordance with the specified requirements.

   c. All drive equipment operates without being overloaded.

4.71.5 Service and Warranty

All equipment shall be guaranteed against defects in material and workmanship for a period of one year from date of OWNER's final inspection and acceptance to the effect that any defective equipment shall be repaired or replaced without cost or obligation to the OWNER.

4.71.6 Operating Conditions

A. See followings for odor control system operating conditions.

TABLE 1
LIFT STATION ODOR CONTROL
OPERATING CONDITIONS

Requirements	
Average H2S Level	≤50 ppm
Peak H2S Level	100 ppm
Ventilation Rate	250 cfm

TABLE 2
FORCE MAIN ODOR CONTROL
OPERATING CONDITIONS

Requirements	
Average H2S Level	≤25 ppm
Peak H2S Level	50 ppm
Ventilation Rate	12.5 cfm

Odor control systems shall have integral irrigation system and be capable of functioning with potable water chloramine and/or free-chlorine average levels between 1 and 3, but up to 5 ppm.

4.71.7 Acceptable Manufacturers

Lift Station Odor Control System: ANUA Airashell

Force Main Odor Control System: Bioteg Ventilation Shaft Biofilter

The specifications and project drawings depict equipment and materials manufactured by the accepted suppliers which are deemed most suitable for the service anticipated. It is not intended, however, to eliminate other products of equal quality and performance. The CONTRACTOR shall prepare his bid based only on accepted equipment for purposes of determining low bid. Award of a contract shall constitute an obligation to furnish the specified equipment and materials.

In event the CONTRACTOR desires to submit an equipment substitution, the CONTRACTOR shall submit requested substitution to the OWNER a minimum of 10 days prior to bid closing. If the proposed substitution requires any resulting changes to the enclosures, buildings, piping or electrical systems to accommodate the proposed equipment, the CONTRACTOR shall do so at his own expense. All product information, including specifications and revised detail drawings illustrating the substituted equipment, shall be submitted to the OWNER prior to acceptance. If accepted, the cost difference of the proposed substitution shall be reflected in the CONTRACTOR's unit bid.

Proposed alternates will be evaluated by the OWNER for cost effectiveness, acceptability for the application, maintenance considerations and compliance with the Contract Documents. If a proposed substitution is determined to be acceptable for the project, the OWNER will notify bidders through an Addendum to the bid documents.

If the OWNER accepts an equipment substitution, it does not relieve the CONTRACTOR from his/her responsibility for full compliance with the contract documents.

4.71.8 Control Panel

A. A control system shall be provided containing all of the electrical equipment necessary to provide for the operation of the odor control system, submersible sump-pump and blower as specified herein, depicted on the drawings, or required for the proper operation of the system. The door shall open a minimum of 180 degrees with a door holder. A padlock hasp shall be provided. All hardware and fittings shall be stainless steel. Odor control system shall be supplied with 480V, 3 phase power.

B. Control panel enclosure shall be NEMA 4X stainless steel.

C. The power system shall contain incoming power terminals, main circuit breaker, motor circuit breakers, and control circuit breaker. All circuit breakers shall be heavy duty thermal magnetic or motor circuit protector. Each breaker shall be sized to adequately meet the operating conditions of the load and have a minimum interrupting capacity of 42,000 amps at 480 volts. Breakers shall be indicating type, providing "on/off/tripped" positions on the handle. They shall be quick-make quick-break on manual and automatic operation and have inverse time characteristics. Breakers shall be designed so that tripping of one pole automatically trips all poles.

D. The enclosure shall be equipped with the following minimum equipment/capability:

1. Main circuit breaker.
2. PLC.
3. VFD for the blower motor.
4. Newark HG2G-5TT22TF-B color touch screen, or equal.
5. Individual motor circuit breaker disconnects.
6. Separate control and alarm circuit fuses.
7. Terminal Blocks.
8. Isolated terminal for neutral wire & grounding.
9. Control power circuit breaker.
10. Lightning arrester.
11. Phase monitor.
12. Schematic diagram in box cover.
13. Red light and audible horn alarms.
14. Dry contacts for remote indication of all alarm conditions.
15. UL508-approved panel design.

E. The control panel shall provide for on/off controls of the blower and sump-pump as well as sump low level float alarm using equipment supplied by the odor control manufacturer. The blower motor speed shall be manually adjusted from the HMI.

F. Sump Low Level Alarm shall be provided by a single float mechanism to be provided by the odor control manufacturer. When activated, the sump low level alarm signal shall provide signal to station SCADA, activate alarm light and disallow operation of the sump pump.

G. Provide the following dry contact outputs for OWNER monitoring:

1. Sump low level alarm.
2. VFD fail.
3. Blower Run.
4. Blower fail.
5. Sump pump run.
6. Sump pump fail.

H. Provide the following communications ports.

1. RS-232 serial port.
2. Ethernet 10BASE-T/100BASE-TX.
3. USB-2.0 (2).

All alarms and Blower Motor speed shall be available in Modbus over the Ethernet port.

I. Temperature Control:

1. Enclosure Heaters: Provide thermostatic controlled heaters when indicated on the drawings or Equipment Specification. Heaters shall be size to maintain an environment within the manufacturer's rating for all equipment within the cabinet.

2. Enclosure Conditioning: If required to maintain the internal enclosure temperature below the maximum rating of the equipment, provide enclosure mounted air conditioning or ventilation equipment.

4.71.9 Blower

A. Odor Control blower shall be controlled by a VFD from the control panel and shall operate at the target ventilation rate.

B. Motor shall be 0.75 HP

C. Blower fan shall be manufactured according to ISO 9001-2000 and tested for air flow according to ISO 5801 standards. Blower fans shall be made from polypropylene flame retardant materials, with no exposed metal components exposed to the air stream.

D. The noise level shall not exceed 60 dB at 10 ft.

4.71.10 Sump

A. Sump shall be constructed of pre-cast or cast-in-place concrete to the size and dimensions shown on the drawings or required for the proper operation of the system.

B. Sump pump shall be 0.5 HP with 2-inch discharge and must be capable of operating at the ranges required for proper operation of the odor control system as specified by the odor control manufacturer.

C. Sump structure shall be equipped with standard 30”x30” aluminum diamond plated hatch cover and shall be constructed such as to prohibit the entrance of foreign debris (leaves, etc.) into the irrigation stream.

D. Sump shall have a 1/2" PVC Sch 80 potable water supply that enters through the top of the sump and maintains a minimum 4-inch air gap above the water level. Water inflow will be controlled by a 1/2" PVC Sch 80 manual ball valve in valve box immediately outside the sump. All exposed piping shall be insulated with weatherproof, Aluminium-jacketed insulation.

E. Sump shall have a 3” PVC Sch 40 drain connection from the odor control unit and 4” PVC Sch 40 drain line to the wastewater collection system.

4.71.11 Installation

Install the equipment as indicated and in accordance with the manufacturer's written instructions.

A. Lift Station Odor Control Unit:

Air piping from wet well to lift station odor control unit shall be 10” HDPE DR 11 fused-joint pipe. Air piping shall maintain a minimum 0.5% slope to the wet well.

Water supply piping shall be 1/2” Schedule 40/80 PVC piping. All exposed water supply piping shall be insulated with 2” thick closed-cell elastomeric insulation with Aluminum jacketing.

Drain piping shall be 4” Schedule 40 PVC piping at a minimum 1% slope to the discharge.

The control panel shall be installed on the main lift station control panel rack, as indicated on the plans.

B. Force Main Odor Control Unit:

Air piping from the force main air/vacuum release valve to force main odor control unit shall be 2” SCH 80 PVC.

The CONTRACTOR shall be responsible for all material furnished and installed, and shall replace, at no expense to the OWNER, all material that is found to be defective in manufacture. The CONTRACTOR shall also be responsible for all material that has become damaged during delivery, handling, installation or start-up. Protect all equipment after installation until final acceptance by OWNER.

4.71.12 Field Testing, Training and Startup

The services of a factory-trained and fully-qualified representative shall be provided to inspect the completed installation, make all adjustment necessary to place the system in trouble-free operation and instruct the operating personnel in the proper operation, care and maintenance of the equipment. Training shall be at least four (4) hours. Visit to be after water is available and pumps can be operated for extended periods.

4.71.13 Measurement and Payment

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

SECTION 01300

SUBMITTALS

PART 1 GENERAL

1.1 SECTION INCLUDES:

A. Submittal Procedures.

B. Construction Progress Schedules.

C. Shop Drawings.

D. Product Data.

E. Manufacturer's Installation Instructions.

F. Manufacturers' Certificates.

1.2 SUBMITTAL PROCEDURES:

A. CONTRACTOR shall submit a complete list of anticipated submittals, including a specification and drawing reference, within 20 days after date established in Notice to Proceed.

B. Transmit each submittal with OWNER accepted form.

C. Submit only electronic copies to the OWNER. OWNER will review and submit an electronic copy back to the CONTRACTOR. All electronic files shall be in PDF format and shall contain no pages larger than 11" x 17".

D. Each submittal shall be limited to a single specification section or material topic. Where equipment packages, assemblies, and the like are interrelated, the submittals should be provided together facilitating review of the CONTRACTOR's purposed offering. When related portions of an equipment package or system are not provided, the submittals may be returned without review.

E. Sequentially number the transmittal form. Revise submittals with original number and a sequential alphabetic suffix.

F. Numbering transmittal form:

1. Include as prefix the specification section followed by a series number "-xx" beginning with "01" and increasing sequentially with each additional transmittal.

2. If more than one (1) submittal under any specification section assign consecutive section numbers to subsequent transmittal letter.

G. Identify Project, CONTRACTOR, Subcontractor or supplier; pertinent Drawing and detail number, and Specification section number, as appropriate.

H. Describing transmittal contents:

1. Provide listing of each component or item in submittal capable of receiving an independent review action.

2. Identify for each item the Manufacturer and MFR's drawing or data number.

I. Apply CONTRACTOR's stamp, signed or initialed, certifying that review, verification of Products required, field dimensions, adjacent construction Work, and coordination of information, is in accordance with the requirements of the Work and Contract Documents.

J. Schedule submittals to expedite the Project, and deliver to OWNER. Coordinate submission of related items.

K. For each submittal for review, allow 10 working days excluding the day that the OWNER receives the electronic submittal.

L. Identify variations or exceptions from Contract Documents and Product or system limitations which may be detrimental to successful performance of the completed Work.

M. Provide space for CONTRACTOR and OWNER review stamps.

N. Revise and resubmit, identify all changes made since previous submission and resubmit the submittal in its entirety.

O. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report any inability to comply with provisions.

P. All submittals and all pages of all copies of a submittal shall be completely legible.

Q. Submittals which, in the OWNER's sole opinion, are illegible will be returned without review.

1.3 CONSTRUCTION PROGRESS SCHEDULES:

A. Submit initial schedule at the Pre-Construction Meeting.

B. Revise and resubmit as required.

C. Submit revised schedules with each Application for Payment, identifying changes since previous version.

D. Submit a horizontal bar chart with separate line for each major section of Work or operation, identifying first work day of each week.

E. Indicate estimated percentage of completion for each item of Work on each Application for Payment submission.

1.4 SHOP DRAWINGS:

A. Submit only electronic copies to the OWNER. OWNER will review and submit an electronic copy back to the CONTRACTOR. All electronic files shall be in PDF format and shall contain no pages larger than 11″ x 17″.

B. After review, produce copies and distribute in accordance with the SUBMITTAL PROCEDURES article above and for record documents purposes described in Section 01700--CONTRACT CLOSEOUT.

1.5 PRODUCT DATA:

A. Submit only electronic copies to the OWNER. OWNER will review and submit an electronic copy back to the CONTRACTOR. All electronic files shall be in PDF format and shall contain no pages larger than 11″ x 17″.

B. Mark to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information unique to this Project.

C. After review, produce copies and distribute in accordance with the SUBMITTAL PROCEDURES article above and provide copies for record documents described in Section 01700 - CONTRACT CLOSEOUT.

1.6 MANUFACTURER INSTALLATION INSTRUCTIONS:

A. When specified in individual Specification sections, submit manufacturer’s instructions for delivery, storage, assembly, installation, start-up, adjusting, and operating to OWNER in electronic PDF format.

1.7 MANUFACTURER CERTIFICATES:

A. When specified in individual Specification sections, submit certification by manufacturer to OWNER in electronic PDF format.

B. Indicate material or Product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.

C. Certificates may be recent or previous test results on material or Product, but must be acceptable to OWNER.

PART 2 PRODUCTS

Not used

PART 3 EXECUTION

Not used.

END OF SECTION

SECTION 04200

UNIT MASONRY

PART 1 GENERAL

1.1 SECTION INCLUDES:

A. Concrete Masonry Units.

B. Reinforcement, Anchorage, and Accessories.

1.2 REFERENCES:

A. ANSI/ASTM A82--Cold-Drawn Steel Wire for Concrete Reinforcement.

B. ASTM A123--Zinc (Hot-Dip Galvanized) Coating or Iron and Steel Products.

C. ASTM A525--Steel Sheet, Zinc Coated, (Galvanized) by the Hot-Dip Process.

D. ASTM A615--Deformed and Plain Billet Steel Bars for Concrete Reinforcement.

E. ASTM B370--Copper Sheet and Strip for Building Construction.

F. ASTM C90--Hollow Load Bearing Concrete Masonry Units.

G. IMIAC--International Masonry Industry All-Weather Council: Recommended Practices and Guide Specification for Cold Weather Masonry Construction.

H. ASTM C270--Specification for Mortar for Unit Masonry.

I. ASTM C426--Test for Drying Shrinkage of Concrete Block.

J. ASTM C476--Specification for Grout for Masonry.

1.3 SUBMITTALS:

A. Submit shop drawings indicating bars sizes, spacings, locations, quantities of reinforcement, bending and cutting schedules, support and spacing devices.

B. Submit product data for concrete masonry units and fabricated wire reinforcement.

C. Submit color samples of concrete masonry units to illustrate color, texture, and extremes of color range.

1.4 QUALIFICATIONS:

A. Installer: Company specializing in performing the work of this Section with minimum 5 years documented experience.

1.5 MOCK-UP:

A. Provide 48-inch by 48-inch mock-up of composite masonry construction with specified mortar and accessories.

B. When accepted, mock-up will demonstrate minimum standard for the work.

C. Mock-up may not remain as part of the work.

1.6 ENVIRONMENTAL REQUIREMENTS:

A. Materials and surrounding air temperature shall remain minimum 50 degrees Fahrenheit prior to, during, and 48 hours after completion of masonry work.

1.7 SEQUENCING AND SCHEDULING:

A. Coordinate work under this Section as necessary with other related trades.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS--CONCRETE MASONRY UNITS:

A. Featherlite Building Products.

B. Acme Brick.

C. Elgin-Butler.

D. Or approved equivalent.

2.2 CONCRETE MASONRY UNITS:

A. Hollow Block Units: ASTM C90, Grade N, Type I--Moisture Controlled; normal weight, with integral water proofing agent.

B. Size: Nominal modular size of 8" x 8" x 16". Provide special units for bond beams, lintels, control joints, 90 degree corners.

C. Decorative Block Units: ASTM C90, Grade N, Type I--Moisture Controlled, color as selected to the following design:

1. Rock Flack Block.
2. Standard Block with integral color.

D. Polystyrene Insulation Inserts:

1. Meet or exceed ASTM C236-80 and Federal Specification HH-I-524C.

2. Equal to Korfil block insulation as manufactured by Korfil Incorporated, Chicopec, MA.

2.3 REINFORCEMENT AND ANCHORAGE:

A. Single Wythe Joint Reinforcement: Truss type; hot dip galvanized after fabrication, cold-drawn steel conforming to ANSI/ASTM A82, 3/16 side rods with 3/16-inch cross ties; Equal to Block-Trus as manufactured by AA Products.

B. Strap Anchors: As required for masonry to masonry wall anchorage.

2.4 FLASHING:

A. Copper/Kraft Paper Flashings: 3 oz/sq ft sheet copper bonded to fiber reinforced asphalt treated Kraft paper; Equal to Cop-A-Cote as manufactured by Afco Products, Inc.

B. Twenty-four (24) gauge flashing receiver as indicated.

2.5 ACCESSORIES:

A. Preformed Control Joints: Rubber material. Provide with corner and tee accessories, heat fused joints.

B. Joint Filler: Closed cell polyvinylchloride; oversized 50 percent to joint width; self-expanding; size as indicated, or standard.

C. Building Paper: #30 asphalt saturated felt.

D. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.

2.6 LINTELS:

A. Solid bottom bond beam-type.

2.7 MORTAR:

A. Mortar mixes: Conform to ASTM C 270, and the following:

1. Type "S" Mortar, for all masonry. One part Portland Cement, 1/4 to 1/2 part hydrated lime, 2-3/4 to 4-1/2 parts damp, loose sand or 1/2 part Portland Cement, 1 part masonry cement, 3-3/8 to 4-1/2 parts damp, loose sand.

2. White Portland cement and/or lime shall be used in the mortar at all light colored block that will require tinting to match the block.

B. Portland Cement: ASTM C 150, Type 1, one sack 94# net, considered one cubic foot.

C. Masonry Cement: ASTM C 91 furnished in sacks containing one cubic foot each, marked with the weight. One sack considered one cubic foot. Exterior masonry cement shall contain integral waterproofing. Masonry cement shall be manufactured by Atlas, Lehigh, Lonestar, Trinity, or an

approved equal.

D. Sand: (Fine Aggregate) 80# damp, considered one cubic foot ASTM C 144 of acceptable color graded within the following limits:

	Percent of Sand Retained (by weight)	
Sieve no.	Max.	Min.
4	0	0
8	5	0
16	40	0
30	65	0
50	85	65
100	98	85

E. Water: Clean and free from injurious amounts of oil acids, soluble salts, and organic impurities.

F. Colors shall be as selected by OWNER and shall closely match the color of the block.

G. Do not lower the freezing point of mortar by use of admixtures or antifreeze agents.

H. Do not use calcium chloride in mortar or grout.

2.8 GROUT:

A. Provide grout with a minimum compressive strength of 2500 psi at 28 days; 7-8 inch slump; premixed type in accordance with ASTM C94 or mixed in accordance with ASTM C476 coarse grout.

PART 3 EXECUTION

3.1 EXAMINATION:

A. Verify that field conditions are acceptable and are ready to receive work.

B. Verify items provided by other Sections of work are properly sized and located.

C. Verify that built-in items are in proper location, and ready for roughing into masonry work.

D. Beginning of installation means installer accepts existing conditions.

3.2 PREPARATION:

A. Direct and coordinate placement of metal anchors supplied to other Sections.

B. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.

3.3 COURSING:

A. Establish lines, levels, and coursing indicated. Protect from displacement.

B. Maintain masonry courses to uniform dimensions. Form vertical and horizontal joints of uniform thickness.

C. Lay concrete masonry units in running bond. Course one unit and one mortar joint to equal 8 inches. Form concave mortar joints.

3.4 PLACING AND BONDING:

A. Lay hollow masonry units with face shell bedding on head and bed joints.

B. Buttering corners of joints or excessive furrowing of mortar joints are not permitted.

C. Remove excess mortar as Work progresses.

D. Interlock intersections and external corners.

E. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.

F. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.

G. Isolate masonry partitions from vertical structural framing members with a control joint.

H. Isolate top joint of masonry partitions from horizontal structural framing members and slabs or decks with compressible joint filler.

3.5 REINFORCEMENT AND ANCHORAGES--REINFORCED UNIT MASONRY:

A. Install horizontal joint reinforcement 16 inches o.c.

B. Place masonry joint reinforcement in first horizontal joints above and below openings. Extend minimum 16 inches each side of opening.

C. Place joint reinforcement continuous in first and second joint below top of walls.

D. Lap joint reinforcement ends minimum 6 inches. Extend minimum 16 inches each side of openings.

E. Support and secure reinforcing bars from displacement. Maintain position within 1/2-inch of dimensioned position.

F. Embed anchors attached to structural steel members.

G. Reinforce stack bonded unit joint corners and intersections with strap anchors.

H. Utilize low-lift grouting techniques in cells containing vertical reinforcing.

I. Remove insulating inserts from cells to receive vertical reinforcing.

3.6 MASONRY FLASHINGS:

A. Extend flashings through veneer, turn up minimum 8 inches and bed into mortar joint of masonry back-up.

B. Lap end joints minimum 6 inches and seal watertight.

C. Provide flashing receiver as indicated on the drawings.

3.7 LINTELS:

A. Install lintels over window openings, door openings, and louvers.

B. Install reinforced unit masonry lintels over openings where steel lintels are not scheduled.

C. Openings Up to 42 Inches Wide: Place two No. 5 reinforcing bars one inch from bottom web.

D. Openings Over 42 Inches Wide: Place two No. 6 reinforcing bars one inch from bottom web.

E. Use single piece reinforcing bars only.

F. Support and secure reinforcing bars from displacement. Maintain position within 1/2-inch of dimensioned position.

G. Place and consolidate grout fill without displacing reinforcing.

H. Allow masonry lintels to attain specified strength before removing temporary supports.

3.8 GROUTED COMPONENTS:

A. Reinforce bond beam as shown on the drawings.

B. Lap splices minimum 24 bar diameters.

C. Support and secure reinforcing bars from displacement. Maintain position within 1/2-inch of dimensioned position.

D. Place and consolidate grout fill without displacing reinforcing.

E. At opening locations, fill masonry cores with grout for a minimum 24 inches either side of opening.

3.9 ENGINEERED MASONRY:

A. Lay masonry units with core cells vertically aligned and cavities between wythes clear of mortar and unobstructed.

B. Place mortar in masonry unit bed joints back 1/4 inch (16 mm) from edge of unit grout spaces, bevel back and upward. Permit mortar to cure 7 days before placing grout.

C. Reinforce masonry unit cores with reinforcement bars and grout as indicated.

D. Retain vertical reinforcement in position at top and bottom of cells and at intervals not exceeding 100 bar diameters.

E. Grout spaces less than 2 inches in width with fine grout using low-lift grouting techniques. Grout spaces 2 inches or greater in width with course grout using low-lift grouting techniques.

F. When grouting is stopped for more than one hour, terminate grout 1-1/2 inch below top of upper masonry units to form a positive key for subsequent grout placement.

G. Low-Lift Grouting: Place first lift of grout to a height of 16 inches and rod for grout consolidation. Place subsequent lifts in 16-inch increments and rod for grout consolidation.

3.10 CONTROL AND EXPANSION JOINTS:

A. Do not continue horizontal joint reinforcement through control and expansion joints.

B. Install preformed control joint devices in continuous lengths. Seal butt and corner joints in accordance with manufacturer's instructions.

C. Size control joint as indicated, or under standard procedures.

3.11 BUILT-IN WORK:

A. As work progresses, build in metal door frames, window frames, anchor bolts, plates and other items furnished by other Sections.

B. Build in items plumb and level.

C. Bed anchors or metal door and glazed frames in adjacent mortar joints. Fill frame voids solid with grout. Fill adjacent masonry cores with grout minimum 12 inches from framed openings.

D. Do not build in organic materials subject to deterioration.

3.12 TOLERANCES:

A. Maximum Variation From Unit to Adjacent Unit: 1/32 inch.

B. Maximum Variation From Plane of Wall: 1/4 inch in 10 feet and 1/2 inch in 20 feet or more.

C. Maximum Variation From Plumb: 1/4 inch per story noncumulative; 1/2 inch in two stories or more.

D. Maximum Variation From Level Coursing: 1/8 inch in 3 feet and 1/4 inch in 10 feet, 1/2 inch in 30 feet.

E. Maximum Variation of Joint Thickness: 1/8 inch in 3 feet.

3.13 CUTTING AND FITTING:

A. Cut and fit for pipes, conduit, sleeves, and duct work. Coordinate with other Sections of work to provide correct size, shape, and locations.

B. Obtain OWNER's approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.14 CLEANING:

A. Remove excess mortar and mortar smears.

B. Replace defective mortar. Match adjacent work.

C. Clean soiled surfaces with cleaning solution.

D. Use non-metallic tools in cleaning operations.

3.15 PROTECTION OF FINISHED WORK:

A. Protect finished installation.

B. Without damaging completed work, provide protective boards at exposed external corners which may be damaged by construction activities.

END OF SECTION

SECTION 16000

GENERAL REQUIREMENTS FOR ELECTRICAL WORK

PART 1 GENERAL

1.1 SECTION INCLUDES:

General requirements for electrical work. This includes quality standards and system testing.

1.2 REFERENCES:

A. The 2014 National Electrical Code (NFPA 70).

B. The National Electrical Safety Code (ANSI C-2).

C. The Life Safety Code (NFPA 101).

D. The International Building Code.

1.3 SUBMITTALS:

A. Where specified, submittals shall be provided in accordance with Section 01300. The submittals shall be identified by the specified equipment number and specification section.

B. Submit results of the testing services as specified herein.

1.4 QUALITY ASSURANCE:

A. All work shall meet the requirements of the NEC and the City of San Angelo codes and regulations.

B. Installation shall be supervised by an electrician licensed as a "Master Electrician."

C. Field work shall be under the continuous supervision of a licensed "Journeyman or Master Electrician."

D. Licensing as a "Master" or "Journeyman" electrician shall mean to hold a current certification or license to that effect issued by the State of Texas. Additionally, if the local authority having jurisdiction requires a local license, the Contractor shall maintain licensed electricians that meet the requirements of the local authority. Submit copies of current licenses or certificates for persons employed on the work. Notify Engineer and remove from the work (within 10 days) any persons for whom a license or certificate is suspended, revoked, or is otherwise rendered void by the issuing agency.

E. The drawings and specifications are complementary. What is shown on one is binding whether shown or specified in the other or not. Failure to check both the drawings and specifications will not be grounds for a change order if additional equipment or material is required to be provided by the Contractor after the Engineer reviews, or deficiencies are identified during testing, either in

the Factory or in the field.

1.5 EQUIPMENT ACCESSIBILITY:

A. All equipment requiring access for monitoring, controlling other equipment, or servicing shall be accessible. Motor starters and other control equipment shall be installed at a height that will allow an operator to view or control the equipment without stooping or without requiring a platform, stool, or raised floor to view or control the equipment. Generally, motor starters, panels, and similar equipment shall be installed with the top of the enclosure at approximately 5'-6" above floor level. Control stations, and other small enclosures that require normal access, shall be installed with the top of the enclosure at approximately 48-inches above floor level.

B. Equipment that is not considered accessible by the Engineer or Owner shall be relocated by the Contractor, at the request of the Engineer or Owner, at no additional cost to the Owner.

1.6 STORAGE OF MATERIALS AND EQUIPMENT:

Materials and equipment shall be stored so as to protect the materials and equipment during storage. Equipment and materials to be located outdoors may be stored outdoors if protected against moisture condensation. Equipment shall be stored at least 6 inches above ground. Equipment and materials to be located indoors shall be stored indoors. Instrumentation shall be stored indoors.

PART 2 PRODUCTS

2.1 COATING SYSTEM:

A. GENERAL:

Where specified, electrical equipment in Division 16 shall be painted by the manufacturer as specified below.

B. FINISH:

Equipment shall be treated with zinc phosphate, bonderized or otherwise given a rust-preventative treatment. Equipment shall be primed, painted with enamel and baked. Minimum dry film thickness shall be 3 mils.

C. COLOR:

Exterior color shall be ANSI 61, gray. Interior shall be painted white. Nonmetallic electrical enclosures and equipment shall be the manufacturer's standard gray or beige color.

2.2 TERMINAL BLOCKS:

Unless otherwise specified, terminal blocks shall be screw terminal, heavy duty, rated at 600V AC. Minimum capacity for control service is 5 amps. Terminals shall be provided with integral marking strips which shall be permanently identified as shown on the shop drawings or required for installation.

2.3 MISCELLANEOUS METAL:

Miscellaneous metal installed in conjunction with electrical or instrumentation work shall be stainless steel. Painted steel is not acceptable. Materials included in this specification group includes, but is not limited to bars, rods, sheet, plate, channel, or other metal shapes used to, or incorporated in support frames, brackets, mounting plates, etc. Steel parts shall be hot-dipped galvanized after fabrication. Bolts, nuts, screws, washers, or similar ancillary materials used shall be 316 stainless steel for exterior areas.

2.4 QUALITY CONTROL:

All work shall be furnished, installed, and connected in accordance with the National Electrical Code, these specifications, and the drawings. All materials used in this work shall be new and shall bear the inspection label of Underwriter's Laboratories, Inc.

PART 3 EXECUTION

3.1 GENERAL:

A. Drawings are generally diagrammatic and show the arrangement and location of fixtures, equipment, and conduit. Not all conduit, wire, and cable are shown on the Engineers drawings. The Electrical Contractor shall provide all that is necessary for a complete and functional system. The Electrical Contractor shall carefully investigate the structural and finish conditions affecting his work and arrange his work accordingly.

B. Any discrepancy between the Contract Documents and the existing conditions or any provision of any Law or Regulation applicable to the performance of the Work or of any standard, specification, manual or code, the Electrical Contractor shall report to the Engineer in accordance with the Standard Conditions of the Contract.

C. Where exact locations are required by equipment for stubbing-up and terminating conduit concealed in floor slabs, the Electrical Subcontractor shall request shop drawings, equipment location drawings, foundation drawings, and any other data required by him to locate the concealed conduit before the floor slab is poured. Additional penetrations/openings not shown on the drawings shall not be made without preapproval by the Engineer.

D. Materials, equipment, or labor not indicated, but which can be reasonably inferred to be necessary for a complete installation shall be provided. Drawings and Specifications do not undertake to indicate every item of material, equipment, or labor required to produce a complete and properly operating installation.

E. The right by the Owner and Engineer is reserved to make reasonable changes in locations of equipment indicated on drawings prior to rough-in without increase in contract cost.

F. The Contractor shall not reduce the size or number of conduit runs indicated on the drawings without the written approval of the Engineer.

G. Locate pull boxes, panelboards, control pushbuttons, terminal cabinets, safety switches, and such other apparatus that may require periodic maintenance, operation, or inspection, so that they are easily accessible. If such items are shown on the plans in locations which are found to be inaccessible, the Engineer shall be advised of the situation before work is advanced to the point where extra costs will be involved.

H. All additional circuit connections to panelboards shall be preapproved by the Engineer.

I. Any work installed contrary to Contract Drawings shall be subject to change as directed by the Engineer, and no extra compensation will be allowed for making these changes.

J. The location of equipment fixture outlets, and similar devices shown on the Drawings are approximate only. Do not scale drawings. Obtain layout dimensions for equipment from Architectural plans unless indicated on electrical plans.

3.2 RACEWAY INSTALLATION:

Use the following raceway materials for raceways in the identified applications.

A. Rigid PVC: Buried Raceways.

B. Rigid Steel: Outdoors.

C. Rigid Aluminum: Where indicated or specified.

3.3 PHASE CONNECTIONS:

Phase connections for equipment shall be A, B, C, counting from front to back, top to bottom, and left to right as viewed from the operating mechanism side. Conductors shall be color coded as specified.

3.4 TESTING:

A. GENERAL:

Prior to energizing the electrical circuits, the following tests shall be performed. Unless otherwise specified, a 1000 volt megohmmeter shall be used for resistance measurements. Record and submit test results using form at the back of this Section.

B. INSULATION RESISTANCE MEASUREMENTS:

Test all energized electrical components including conductors for circuits 120V volts and higher. Conductors and devices with less than 50 megohms resistance to ground or between conductors or phases shall be removed and replaced. All conductors in a raceway shall be removed if a conductor in that raceway fails the insulation resistance test. The conductors shall not be reused.

C. MOTOR TESTS:

All motors shall have their insulation resistance measured before they are connected. Insulation resistance values less than 10 megohms are not acceptable. Verify that motors are connected to rotate in the correct direction. Verification may be accomplished by momentarily energizing the motor, provided the Contractor confirms that neither the motor nor the driven equipment will be damaged by reverse operation. Measure the full load current on each phase with the motor running at maximum operating load.

D. FUNCTIONAL CHECKOUT:

Protective devices shall be adjusted and operative during the testing period. Prior to start-up of each piece of equipment or system, perform a functional checkout on control circuits. The checkout shall consist of energizing each control circuit and operating each control, alarm, or malfunction device, and each interlock in turn to verify that the specified action occurs. This may be performed with the motor connected or disconnected. Providing that no harm will be done to the equipment.

3.5 AS-BUILT DRAWINGS:

At the end of the project, provide one set of "red-lined" as-built drawings to the Engineer. As-built drawings shall show all addenda, change orders, or other modifications made by the contractor or directed by the Engineer/Owner. Drawings shall be complete and shall be accurate. Manholes and other in-ground structures shall be dimensioned from a known structure. Modifications to control schematics shall be marked on the drawings. Final payment will not be made until as-built drawings are accepted by the Engineer.

END OF SECTION

MOTOR, CIRCUIT, AND DEVICE
ELECTRICAL TEST RESULTS

PROJECT _____

OWNER _____

DATE _____

CIRCUIT OR
EQUIPMENT ID _____

1 PHASE 3 PHASE 120 VOLT 208 VOLT 480 VOLT _____ VOLT

MEASURED VOLTAGES: MEASURED CURRENT:

PH. A--GND _____ A-B _____ PH. A _____ AMPS

PH. B--GND _____ B-C _____ PH. B _____ AMPS

PH. C--GND _____ A-B _____ PH. C _____ AMPS

MEASURED INSULATION RESISTANCE, MEG OHMS, PHASE TO GROUND @ 1,000 VOLTS:

PH. A _____ PH.B _____ PH.C _____

MOTOR NAMEPLATE DATA:

VOLTS _____ pH _____ SF _____ FLA _____

THERMAL OVERLOAD DEVICE:

MFG: _____ CAT/PART NO. _____ AMPS _____ SETTING _____

OPERATING CONDITIONS:

COMMENTS:

_____ _____
CONTRACTOR'S SIGNATURE INSPECTOR'S SIGNATURE

SECTION 16100

SEWAGE LIFT STATION CONTROL PANEL

PART 1 GENERAL

1.1 SECTION INCLUDES:

A. Furnish and install a new pump control panel (PCP) with all necessary installation accessories and appurtenances, training and start-up to control a complete and functional two-pump sewage lift station as specified.

B. The system shall be provided with a primary level control system and a backup level control system. In the event the primary level control system fails, the PCP shall automatically switch to the backup level control system and alarm to SCADA.

C. The PCP shall be provided with a programmable logic controller (PLC) to provide pump control from the primary level control system and to provide SCADA interface.

D. The Contractor shall design, procure, install, program, and commission all equipment and furnish such activity as required to provide a fully-complete, operable, and integrated pump control system as specified herein and indicated on the drawings.

E. Provide all software, hardware, programming, and any other device or equipment required to conform to these specifications in their entirety.

F. The backup level control system shall operate independently from the PLC.

G. The PLC shall monitor the new Sulphur Draw Lift Station and provide two way communication and control back to the existing City of San Angelo SCADA system. The PCP shall have a programmable logic controller (PLC) located in the enclosure and shall be web-based and communicate with the City of San Angelo SCADA system via the internet as specified herein and indicated on the drawings. The City will provide hardwired internet service at the Lift Station. The Contractor shall provide conduit and other equipment as indicated on the drawings.

H. The drawings and specifications are complementary. What is shown on one is binding whether shown or specified in the other or not. Failure to check both the drawings and the specifications will not be grounds for a change order if additional equipment or material is required to be provided by the Contractor after the Engineer's review, or deficiencies are identified during testing, either in the Factory or the field.

I. The Contractor shall work with and coordinate with the Owner during the installation of the PCP. After the PLC has been programmed and initial setup is complete, the Contractor shall provide eight (8) hours of time to work with Owner personnel. This shall be for the purposes of allowing the Owner to make modifications to the PLC programming to incorporate additional control

features that may be identified during startup or other work as required. Any support needed by the Owner personnel shall be provided by the Contractor and a factory trained representative of the Contractor shall perform this task. This work shall be in addition to the requirements for training or any requirements of the Contractor to make field adjustments to the PCP, including hardware or software modifications that may be required for the PCP to meet the requirements of the specifications.

This work shall be separate from the required training, but may be coordinated with the training.

J. The PCP shall be UL 913 listed for intrinsically safe operation in a Class 1, Division 1 & 2, Groups A, B, C, & D operation.

K. Related Work Specified Elsewhere:

1. Division 1.
2. Division 11.
3. Division 16.

1.2 SUBMITTALS:

A. Submit under provisions of Section 01300.

B. Product Data: Provide manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

C. Shop Drawings:

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Control panel outline drawings showing elevation, plan and interior views, front panel arrangement, dimensions, weight, conduit entrances and anchor bolt pattern. Indicate all options, special features, ratings and deviations from this Section. Furnish complete Bill of Materials indicating manufacturer's part numbers.
b. Power and control schematics including external connections. Show wire and terminal numbers and color coding.
c. Instruction and replacement parts books.
d. Certified shop test reports.
e. As-built final drawings.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For control panels, installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 include the following:

1. Routine maintenance requirements for control panels and all installed components.

2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

F. Submersible level sensor.

G. Float switches.

1.3 QUALITY ASSURANCE:

A. Manufacturer Qualifications: Control panel manufacturer shall demonstrate at least three years of continuous field operating experience in control panel design and fabrication. Submit customer/user list with telephone numbers, addresses and names of customer/user representatives.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NFPA 70.

1.4 PROJECT/SITE CONDITIONS:

A. PCP assembly shall perform as intended under the following conditions without damage to equipment, structure, or derating:

1.	Temperature Range:	0° to 122°F.
2.	Humidity Range:	0 to 100%.
3.	Maximum Wind Velocity:	125 mph.
4.	Elevation:	< 3300 ft.

1.5 APPROVED CONTRACTORS

A. Walker Industrial, Irving, Texas.

B. Prime Controls, Houston, Texas.

PART 2 PRODUCTS:

2.1 CONTROL SEQUENCE OF OPERATIONS:

1. A control system shall be provided containing all of the mechanical and electrical equipment necessary to provide for the operation of the submersible pumps as specified herein, indicated on the drawings, or required for the proper operation of the system.

2. Pump motor size shall be as indicated on the drawings.

3. An alternating relay shall be provided to alternate the lead and lag pumps. The alternating relay shall be separate from the PLC.

4. The PCP shall operate from a primary and a backup level control system. In the event that the primary level control system fails for any reason, the motors shall be controlled by the backup level control system. The backup level control system shall consist of two direct acting floats, high level and pump shutoff, and shall act independently from the PLC.

5. The PLC shall be programmed to operate the pumps based on submersible level transducer input to the PLC and provide the following control points. The actual levels shall be as indicated on the drawings or as directed by the Owner.

    1. Low level lockout.
    2. Pump off.
    3. Lead pump on.
    4. Lag pump on.
    5. High level alarm.

6. The primary level control system shall be capable of being programmed to provide additional set points for well level control or indication as required by the Owner.

7. The backup level control system shall be accomplished by the two float switches installed it the wetwell and shall be limited in wetwell level control points by the physical location of the floats. Upon activation of the high level float switch, the lead pump shall be commanded “ON” followed with a 15 second delay to command the lag pump “ON.” The low level float switch shall command the lead pump “OFF”, followed with a 10 second delay to command the lag pump “OFF.” Perform this sequence each time the wetwell level reaches the high level float switch. If the PCP is operating from generator power, limit operation to the lead pump.

G. The PLC shall perform the following:

    1. Communicate with the existing remote City SCADA system via the Internet.

    2. Monitor the wetwell level and the lift station flow. Wetwell level shall be from the level transmitter. Lift Station flow

shall be from the flowmeter.

3. Record totalized flow. Provide storage for the data for a minimum of 30 days.

4. Monitor all alarms and controls as follows. Provide alarms or information to SCADA as requested by the Owner.

   a. Loss of AC power.
   b. Battery status.
   c. DC Power status.
   d. Lift station flow from the flow meter.
   e. Phase failure alarm.
   f. Wetwell high level alarm.
   g. Wetwell low level-float switch.
   h. Each pump status.
   i. Each pump run time.
   j. Each pump selector switch manual position.
   k. Each pump selector switch automatic position.
   l. Each pump over load alarm.
   m. Each pump seal failure.
   n. Each pump over temperature alarm.
   o. Each pump fail to start.
   p. Each pump low cable resistance.
   q. Pump control panel intrusion alarm.
   r. Loss of primary level control system
   s. Automatic transfer switch in emergency position.
   t. Generator running.
   u. Generator fail to start.
   v. Generator low oil level.
   w. Generator high temperature.
   x. Generator day tank leak detection.
   y. Generator day tank low fuel level shutdown.
   z. Generator day tank low fuel level alarm.
   aa. Odor control unit blower run.
   bb. Odor control unit pump run.
   cc. Odor control unit blower fail.
   dd. Odor control unit pump fail.

   Note: Generator alarms shall be provided over the Ethernet connection between the PLC and the generator control panel.

H. Operation:

1. Pump level system shall provide continuous monitoring of the wet well level through the submersible pressure transducer.

2. The PLC shall start and stop pumps based upon wet well level and operator programmed set points. The PLC shall provide a lead pump start contact and a lag pump start contact to the alternating relay.

3. The pump control panel alternating relay shall alternate pump cycles of the lead and lag pumps to ensure equal run times.

4. When the water level reaches the lead pump "ON" level, the lead pump will operate. If the water level decreases to the pump shutoff, the lead pump will stop and the PLC shall automatically switch the lead/lag operation of the pumps.

5. When the water level reaches the lag pump "ON" level, both the lead pump and the lag pump will operate. The pumps will continue to operate until the wetwell level is pumped down to the pump off level. After the pumps are shut down, the PLC shall revert back to the normal operation.

6. The PLC shall include an automatic override to start the lag pump if the lead pump fails for any reason, or is turned off.

7. The PLC shall monitor pump protection features to provide alarms in event of impending pump failure. It shall also monitor pump performance data to provide operations personnel the ability to evaluate station performance.

8. Upon receipt of a remote contact closure from the automatic transfer switch, the PLC shall limit pump operation to the lead pump. As specified elsewhere, the PCP shall continue to alternate the lead/lag pump operation while the system is operating on the emergency generator.

9. The PCP shall be provided with a selector switch to select which pump will be the lead pump and which shall be the lag pump. The pump controller shall be capable of alternating which individual pump responds to the "Lead Pump Call" and subsequent "Lag Pump Call" signal to control the total pump run time on each of the pumps.

10. The PLC shall contain a real-time clock and shall time and date stamp all logged data. The controller shall store logged data for a period of up to 30 days.

11. Upon loss of power and subsequent restoration of power, the pump control panel shall be provided with an adjustable time delay on start for each pump. After the lead pump time delay has expired, the lead pump shall start. After the time delay has expired for the lag pump, the lag pump shall be allowed to start. If the water level is above the lag pump start or the wetwell high level, the PLC shall start the lag pump.

2.2 ENCLOSURE:

A. The control panel enclosure shall be NEMA 4X type 304 stainless steel with a welded drip shield and constructed from minimum 14 gauge material. All hardware and fittings shall be 304 stainless steel.

B. The enclosure door shall utilize fast operating clamps instead of conventional screw clamps, shall have a seamless foam gasket, and be lockable by means of a padlock. The enclosure shall have a 90 degree opening door with zero clearance and 180 degree opening door with full clearance. The enclosure shall be provided with a door holder.

C. Provide a data pocket on the inside of the front door.

D. Provide a polished aluminum dead front inner door mounted on a continuous aircraft type hinge, containing cutouts for mounted equipment and providing protection for personnel from live internal wiring. Provide cutouts for breaker handles to allow operation of breakers without entering the compartment. Mount all control switches, indicating lights, elapsed time meters, and other operational devices on the external surface of the inner door. The inner door shall open a minimum of 150 degrees to allow access to equipment for maintenance. Form a 3/4" break around the perimeter of the inner door front to provide integrity.

E. A back plate shall be manufactured from 12 gauge sheet steel and shall be finished with a primer coat and two (2) coats of baked on white enamel. All hardware shall be mounted using machine thread screws. Sheet metal or self-tapping screws shall not be acceptable. All installed devices shall be permanently identified with engraved legends.

F. Provide an LED enclosure light mounted at the top of the enclosure. LED light shall be Saginaw Control & Engineering Catalog Number SCE-LF24NO, or equal. Control light by a door switch.

G. The enclosure shall be equipped with the following minimum equipment/capability:

1. Main circuit breaker.
2. PLC.
3. DSL access router.
4. Soft start AC drive for each motor.
5. Individual pump circuit breaker disconnects.
6. Separate control and alarm circuit fuses.
7. Terminal Blocks.
8. Isolated terminal for neutral wire & grounding.
9. Control power circuit breaker.
10. Lightning arrester.
11. Phase monitor.
12. Alternating relay.
13. Digital elapsed time meters.
14. Ammeter for each pump.
15. H-O-A switch for each pump.
16. Lead/Lag pump selector switch.
17. Time delay relay on start for each pump.
18. LED indicating lights for all alarm conditions and pump operation.
19. Schematic diagram in box cover.
20. Red light and audible horn alarm.
21. Set of dry contacts for remote indication of all alarm conditions.

22. Loop isolator for wetwell level transducer.
23. Automatic insulation resistance tester.
24. Intrinsically safe barriers.
25. Ground bus.
26. UL508-approved panel design.

H. Temperature Control:

1. Enclosure Heaters: Provide thermostatic controlled heaters when indicated on the drawings or Equipment Specification. Heaters shall be size to maintain an environment within the manufacturer's rating for all equipment within the cabinet.

2. Enclosure Conditioning: If required to maintain the internal enclosure temperature below the maximum rating of the equipment, provide enclosure mounted air conditioning equipment.

2.3 POWER SUPPLY AND UPS:

Provide power supplies and UPS equipment as follows:

A. Power supply to the panel shall be 120 volts, single-phase. Provide a 120 volt-24 VDC power supply. Output power rating shall be selected for the maximum power requirements of the panel plus 10%. Minimum power output shall be 15 amps.

B. Provide a UPS system complete with battery, DC-UPS control unit, battery controller, and all other components to provide UPS power to the equipment.

C. UPS system shall be sized for the power requirements of the panel and shall provide minimum 26 amp-hour of UPS power.

D. Provide a modular maintenance free battery installed in pan mounted bracket. Battery shall be provided with a blade terminal fuse.

2.4 POWER DISTRIBUTION:

A. The PCP power distribution shall include all necessary components and be wired with stranded copper conductors rated at 90ºC. Conductor terminations shall be as recommended by the device manufacturer.

B. Power supply to the PCP shall be 480 volts, three-phase, 60 Hz.

C. A lightning transit protector shall be provided. The device shall be a solid state device with a response time of less than 5 nanoseconds with a withstanding surge capacity of 6500 amperes. Units shall be instant recovery, long life and have no holdover currents.

D. Provide a control power transformer to step-down power from 480 volts to 120 volts and/or 24 volts. The control power transformers shall be sized to provide all control power requirements for the control panel.

E. The power system shall contain incoming power terminals, main circuit breaker, and motor circuit breakers control circuit breaker. All circuit breakers shall be heavy duty thermal magnetic or motor circuit protector. Each breaker shall be sized to adequately meet the operating conditions of the load and have a minimum interrupting capacity of 42,000 amps at 480 volts. Breakers shall be indicating type, providing "on/off/tripped" positions on the handle. They shall be quick-make quick-break on manual and automatic operation and have inverse time characteristics. Breakers shall be designed so that tripping of one pole automatically trips all poles.

F. Circuit breakers for the motors shall be motor circuit protector type. The main circuit breaker shall be Square D Type FAL, or approved equal.

G. Provide circuit breaker for the enclosure heater.

2.5 WIRING. All wiring shall be in complete conformity with the National Electric Code and state and local and NEMA Electrical Standards.

A. All wiring shall be minimum 600 volt UL type MTW or AWM and have a current-carrying capacity of not less than 125% of the full load current. The conductors shall be in complete conformity with the national electric codes, state, local and NEMA electrical standards. For ease of servicing and maintenance, all wiring shall be color coded. The wire color code shall be clearly shown on the drawings, with each wire's color indicated.

B. All control wiring shall be contained within plastic/PVC wiring duct with covers. Where dimensional constraints prevent the use of wiring duct, wires shall be trained to panel components in groupings. The wire groupings shall be bundled and tied not less than every 3 inches with nylon self-locking cable ties as manufactured by Panduit or equal.

C. Every other cable tie shall be fastened to the enclosure door or inner device panel with a cable tie mounting plate with pressure tape. Where wiring crosses hinged areas such as when trained from the inner device panel to the enclosure door, spiral wrap shall be used.

2.6 Name Plates:

A. Provide permanently attached nameplate to clearly indicate the purpose and operation of the panel and all control devices or lights.

1. Nameplates attached to the exterior of the control panel door or interior panel shall be engraved nameplates constructed from laminated phenolic plastic, at least 1/16" thick, 3-ply, with black surfaces and white core. Engraving shall be condensed gothic, at least 1/4" high, appropriately spaced. Nameplates shall be attached with stainless steel, self-tapping screws.

2. Nameplates or diagrams attached to the back side of panel fronts may be thermal transfer laminated tape and shall be attached with water-proof adhesive that is heat-resistant up to 250° degrees Fahrenheit.

B. All devices shall be identified on the front and back of the applicable panel door or interior panel.

2.7 MOTOR PROTECTION:

A. Motors shall be controlled and protected using solid state soft starts. Soft starters shall be Combination Altistart-48 Soft Start Units, suitable for severe duty applications as manufactured by Square D, or Engineer approved equal. The Soft start shall include the following protective features.

1. Phase loss and under voltage protection.
2. Solid state motor thermal overload protection—programmable from Class 10 through 30. Soft start thermal protection.
3. Motor phase loss protection.
4. Overcurrent fault.
5. Locked rotor fault.
6. Line frequency outside limits +/-5% or +/-20%.
7. Selectable protection, including;
   Phase reversal;
   Stall and jam;
   Thermal overload pre-alarm;
   Current threshold alarm;
   Underload fault.

B. The following shall be supplied as standard equipment:

1. Phase/voltage monitor with two (2) sets of double pole double throw contacts. The phase/voltage monitor shall be provided for remote SCADA alarm.
2. LED type Pump Run/Failure pilot lights as required.
3. Elapsed Time meters for each pump.

C. PUMP PROTECTIVE DEVICES:

1. Each pump shall be protected by a solid state relay to monitor motor winding temperature and seal leakage.

   a. One plug in solid state Mini-Cas 120 or pump safe module unit shall be supplied for each pump to monitor the pump for over-temp and leakage. The unit shall have an 11pin, round base to mate with a standard 11 pin socket. The unit shall also be flanged in order to allow deadfront door mounting. The unit shall be powered by 24VAC. LED indication shall be provided for power on, over-temp, and leakage conditions. An over-temp reset push-button shall be provided to allow reset of the unit. The sensor input circuitry is to contain both hardware and software filters to provide noise immunity, as well as sensor input short circuit protection. The Mini-Cas 120 unit shall be Model 14-407129, as supplied by Flygt Corporation or approved equal.

2. Each pump shall be provided with an electric motor winding insulation monitor. Provide the AutoMeg insulation tester. No equal accepted. Alarm to SCADA.

3. Do not lockout out the pump for events that are not directly associated with the pump, such as under voltage, or phase loss, but only prevent the motors from operating under these conditions. Lockout the motors for events that are directly related to the motor.

2.8 Programmable Logic Controller (PLC):

A. The PLC shall be a Schneider Electric M340 PLC platform. Provide switch mode power supply with Redundancy module and battery backup. Alternates will not be accepted.

B. PLC shall be provided with digital inputs and digital outputs as required to provide the functions and controls as specified herein and as indicated on the drawings.

C. The PLC shall be provided with analog inputs rated for 4-20 mA as required for the instruments indicated.

D. The PLC shall consist of all the components, hardware and software as required to provide a trouble-free pumping station.

E. The PLC shall be provided with the following communications and software capabilities:
1. Modbus serial port.
2. Ethernet TCP/IP.
3. USB port.
4. Embedded Web server.
5. SD memory Card.

2.9 AUXILIARY DEVICES:

A. All devices shall be mounted on the front of the enclosure. No devices shall be mounted on the sides of the enclosure. Devices mounted on the enclosure shall have the same NEMA rating as the enclosure.

B. The alternating relay shall be a microprocessor based controller designed for use where two loads are required to alternate to provide equal run time on the loads. The relay shall be 8-pin socket mounting. Time Mark or equal.

C. Pushbuttons shall be of the heavy-duty oiltight type, mounted on the front of the starter enclosure.

D. Selector switches shall be of heavy duty, oiltight type, mounted on the starter cover.

E. The operator button shall be molded Bakelite and solid in color throughout the material. Painted buttons are not acceptable. A suitable and clearly legible nameplate shall be provided for each button to designate its function.

F. All contact blocks shall be made of molded, high arc resistant material and

shall have a minimum of one normally open, and one normally closed contact, with a continuous current rating of 10 amperes, 600 volts. All terminals shall be readily accessible, contact blocks shall be easily changed, or be arranged for the addition of contacts.

G. Pilot lights shall be an integral part of control station when indicated. Indicating lights shall be push to test LED type, rated for the enclosure. Contractor shall install pushbuttons and selector switches not factory mounted.

H. Provide adjustable 1-60 second "on" time delay relay for each motor to stop the motor on loss of power. Set the first motor relay at 15 seconds and stagger each motor 15 seconds. The time delay shall not conflict with the time delays for lead and lag pump start as programmed in the PLC.

I. LOOP ISOLATORS:

Design and fabrication:

1. Solid state electronics.
2. Transmit analog output signal directly proportional to measured input signal.
3. Power source: 24 VDC.
4. Analog input: 4-20 mA DC or 1-5 VDC.
5. Output signal: 4-20 mA DC into 1400 ohms.
6. Impedance:

    a. Voltage input: 10 Meg.
    b. Current input: 50 ohms.
    c. Voltage output: 1 ohm.
    d. Current output: 1650 ohms.
    e. Accuracy: Better than ± 0.10 percent of span.
    f. Isolation: Up to 500 V rms (input, output and case).
    g. Accuracy: Better than ± 0.10 percent of span.
    h. Isolation: Up to 500 V rms (input, output and case).
    i. Temperature effect: ±0.0025 percent of span per Degree F.
    j. Ambient temperature range: 0-140 Degree F.
    k. Factory calibrated.

J. LOCAL ALARM:

1. A flashing red alarm light shall be provided. The alarm light shall be weatherproof and shatterproof, minimum 4 inch diameter, with an LED lamp. The alarm light shall be located on top of the panel. Penetrations through the enclosure shall be water tight. The alarm light shall be activated for Wetwell High Level.

2. Provide a horn silence pushbutton on the front door of the enclosure. The alarm light shall continue to flash until the alarm condition is corrected.

2.10 PRIMARY LEVEL CONTROL SYSTEM:

The Contractor shall furnish the following, and calibrate the instruments to the specific sewage lift station equipment:

A. Submersible level transducer (SLT) Blue Ribbon Corp. Birdcage® Model BC001, or engineer approved equal. Unit shall have a pressure range suitable for the wetwell depth, and have sufficient cable length to accommodate installed position with **no** splices. The level system shall provide a 4-20 mA signal back to the PLC based on level in the wetwell.

B. The SLT shall be mounted using a stainless steel or similar reinforced cable system in a location that provides proper control of the pumps.

C. Calibrate the level transducer to match the wetwell dimensions.

D. All accessories, clamps, cable, pipe, couplings, bolts, screws and miscellaneous hardware shall be Type 316 stainless steel unless otherwise specified.

E. Provide a sink weight to keep the transducer stable.

2.11 BACK-UP LEVEL CONTROL SYSTEM:

A. The Contractor shall furnish the following backup level control system the following for each PCP required, and calibrate the instruments to the specific sewage lift station equipment.

B. The liquid level of the sewage lift stations shall be sensed secondarily (i.e., redundantly) by a level detecting device that shall consist of float switches with a mercury switch inside and flexibly supported by a PVC jacketed, heavy-duty cable system.

1. The number of floats and the mounting regime shall be as indicated on the drawings or specified herein. Each system shall be installed in accordance with the Manufacturer's instructions.

2. Each float switch shall have a 20 A rating at 115 VAC and 10 A at 230 VAC. The float shall be type SO with three # 14 AWG fine-stranded copper conductors. The float shall be mounted using Type 316 stainless steel hardware.

3. The float switch system shall be furnished in quantities and with such accessories as are required by the Engineer to perform the specified control and alarm functions of these applications.

4. Each float switch system shall contain a SPST-NO/NC switch that makes or breaks circuit as the sensed liquid level rises or falls past the float mounting elevation. The ON/OFF level differential is less than 1-inch so the float essentially senses a single level.

5. Basic float switch system equipment features shall be as follows:

   a. Floats: Type 316 SS, 5½-inch diameter, # 20 gauge, permanently assembled to switch and cable.
   b. Cable: Type SO, 5/8-inch O.D., Nitrile PVC jacket, 3- #14 AWG fine-stranded conductors for heavy flexing, underwater service. Switches shall be colored black and white.
   c. Switch:Tilt type, NO or NC. Low tilt angle shall give less than 1-inch level differential. AC resistive rating 20 amps at 115, 10 amps at 230. AC lamp load 1000 watts. Encapsulated permanent. NO floats are orange. NC floats are red.
   d. Mounting: Clamp tube, bracket and U-bolts are 316 SS.

6. The float switch system shall conform to the following:

   a. Provide wetwell high level alarm signal to the PCP. Such service shall be capable of operating the alarm light, and alarm annunciating station, bells, horns, etc.
   b. When installing the float switch system, the green conductor of the three-wire cable is to be connected to the float body and shall be run to an electrical ground.
   c. The float switch system shall be guaranteed against defects in materials and workmanship for three (3) years from date of shipment from the factory. Defective floats shall be replaced FOB factory in exchange for the defective floats shipped prepaid to the factory.
   d. The float switch system shall be connected to the pump and alarm controller specified above.

7. Provide sink weights as necessary to keep the floats stable or lash the float cables to supports with stainless steel straps. Floats shall be installed such that the movement of the float is not inhibited by other cables or equipment nor does it interfere with maintenance on the pumps.

2.12 DSL ACCESS ROUTER

A. Provide a DSL access router for communication with the existing City of San Angelo SCADA system.

B. The router shall meet the following requirements:

   1. DIN rail mounted.
   2. Power supply provided by the PCP UPS system.
   3. Operating temperature range of -40ºC to +70ºC.
   4. Configuration from following methods:

      a. Web browser (http and https.)
      b. Telnet connection.
      c. SSH connection.
      d. SNMP manager.

5. Provided with the following gateways:

    a. Two independent serial port gateways, RS-232 and RS485. Data rates from 300 to 115,200 bps.
    b. ADSL port. Supports standards ADSL, ADSL2, ADSL2+, and ADSL2+M.
    c. DSL ATM encapsulation protocols: PPPoA, PPPoE, IPoA, MER/IPoE, and CLIP.
    d. Four Ethernet ports, 10/100baseT and Auto-MDI?MDIX. One which can be configured as WAN port.
    e. Two USB2.0 ports. Wireless WAN over USB.

6. Serial ports shall support Modbus RTU/ASCII, DNP3, and IEC60870-5-101.
7. Stateful firewall for Access Control and rate limiting (DoS protection).
8. Device Management: HTTP/HTTPS, Telnet/SSH, SNMP and serial port.
9. Ethernet ports Modbus TCP/IP, DNP3/IP, and IEC60870-5-104.
10. Email, SNMP traps and SMS alerts for reporting system status changes.
11. Hardware versions for Annex A (PSTN overlay) and Annex B/J (ISDN A/B).
12. IPsec and OpenVPN tunnels for secure communication with Ethernet and serial ports.
13. Router shall have the capability to limit communication to pre-defined IP addresses.
14. Secure Layer-2 Ethernet bridging over IPsec and OpenVPN tunnels.
15. Secure access to Serial port gateways. (IPsec or access restrictions in firewall).
16. IP routing: Static or Dynamic routing with RIP Version 1 and 2.
17. IPSec Operation:

    a. Tunnel mode.
    b. Key exchange Method: Automatic IKE or Manual.
    c. Authentication Method: Pre-shared key or X.509 Certificate.
    d. PFS support (Perfect Forward Secrecy): RFC 2412.
    e. Phase 1 mode: Main or Aggressive.\
    f. Phase 1 and 2 Encryption Algorithms: DES-CBC, 3DES-CBC, AES-128-CBC, AES-192-CBC or AES-256-CBC.
    g. Phase 1 and 2 Integrity Algorithms: MD5 or SHA-1.
    h. DH Group 5 (1536 bit), DH Group 14 (2048 bit), DH Group 15 (3072 bit), DH Group 16 (4096 bit), DH Group 17 (6144 bit) or DH Group 18 (8192 bit).
    i. Key Lifetime: 1-28800 seconds.
    j. DPD (dead peer detection.)
    k. NAT-traversal and NAT KeepAlive.
    l. Up to 10 IPsec tunnel configuration profiles.
    m. Layer-2 bridging over IPsec tunnels.

18. Operating modes: TCP server, TCP client, Telnet server, UDP client/server.

C. Provide all software as required and program and configure the router as required to communicate with the remote City of San Angelo SCADA system.

2.13 CABLE HOLDERS:

A. Cable holders shall be constructed of 316 stainless steel.

B. Install, on opposite sides of the wet well hatch opening, separate cable holders (Kellum grips) to support pump power cables (one for each pump in the lift station), float switches, and submersible level transducer. Ensure cables are routed such that any individual pump can be raised from the wet well without interference with adjacent pump/float/transducer cables.

PART 3 EXECUTION

3.1 INSTALLATION:

A. The pump control panel shall be installed as indicated on the plans.

B. All material, devices, supports, and other items in or around the wetwell shall be 316 stainless steel.

3.2 FIELD TESTING AND STARTUP:

A. The services of a factory-trained and fully-qualified representative shall be provided to inspect the completed installation, make all adjustment necessary to place the system in trouble-free operation and instruct the operating personnel in the proper operation, care and maintenance of the equipment. Visit to be after water is available and pumps can be operated for extended periods.

B. Connect the transducer with other system elements and place in successful operation. It shall be provided with input power and output signal transient protection, associated control elements as specified herein and in accordance with the Manufacturer's instructions.

C. Contractor shall set the motor protection from the soft start for the actual motors installed.

D. Test and demonstrate proper operation of system, both primary and backup level control systems. Disconnect the primary level control system to demonstrate operation from the backup level control system.

E. Set pump control to occur at the various wet well levels indicated on the Plans and demonstrate pump operation at each level.

F. Fill basin and allow pump to cycle several times. Then shut off pump and allow basin to fill to trip the high water alarm. Demonstrate that all normal operations and alarm functions of the installed station work as designed and intended.

G. Operate the lift station from the emergency generator and demonstrate that the PCP only allows the lead pump to operate. Turn the lead pump off to demonstrate that the PCP automatically operates the lag pump.

H. Turn power off to the PLC to demonstrate that the PCP operates the pumps from the float switches independent of the PLC.

I. Measure motor current and voltage during testing and submit readings in accordance with section 01300.

3.3 OWNER TRAINING:

A. The Contractor shall supply "factory" personnel to conduct two separate on-site training sessions, totaling a minimum of two days of training. Each day shall consist of at least four (4) hours. .

B. The initial training session shall be conducted during start-up as needed until the Owner and Engineer are satisfied that the operators are comfortable with the operation and maintenance of the system. Training shall be done on site with the Owner's personnel. The actual Operations and Maintenance Manual shall be used for training.

C. Three to six months after the Owner commencing system operation, the Contractor shall supply "factory" personnel to conduct follow-up training of the Owner's personnel. The follow-up training shall be conducted on-site and consist of reviewing the operation and maintenance of the system. The Owner shall be contacted a minimum of two weeks in advance, prior to scheduling the training session to allow proper coordination.

3.4 SPARE PARTS:

A. Furnish spare parts as described below. Material shall be packaged for long term storage and identified with labels describing contents.
   1. One M340 PLC.
   2. Twp 120 volt relays of each type used.
   3. Two 24 VAC relays of each type used.
   4. Two 24 VDC relays of each type used.
   5. One 120 volt AC to 24 VDC power supply.
   6. One 24 VDC UPS.
   7. Spare fuse and bulb for each size and type.

3.5 SCHEMATIC:

A schematic diagram shall be laminated and permanently fastened to the inside of the enclosure. Schematic shall be specific to the control panel and shall reflect as-built conditions. An installation and service manual shall also be included with control panel.

END OF SECTION

SECTION 16110

RACEWAYS AND FITTINGS

PART 1 GENERAL

1.1 SECTION INCLUDES:

A. The work shall include furnishing and installing all rigid steel and flexible metallic conduit, electrical metallic tubing, polyvinyl chloride conduit, wireways, pull and junction boxes and outlet boxes, together with all supporting devices and other accessories required.

1.2 SUBMITTALS:

A. Submit manufacturer's data on all materials, under provisions of Section 01300.

PART 2 PRODUCTS

2.1 CONDUITS:

A. Galvanized Rigid Steel Conduit (GRC): Rigid, threaded, thick-wall; galvanized inside and outside or galvanized outside with a protective coating inside; UL listed and labeled according to Standard UL6; conforming to ANSI Standard C80.1.

B. Rigid Aluminum Conduit: Manufactured of 6063 alloy in temper designation T-1. Fittings shall be of the same alloy. Conform to ANSI C80.5 specification and manufactured in accordance with UL6.

C. PVC-Coated Galvanized Rigid Steel Conduit: Hot dip galvanized inside and out with hot galvanized threads. 40 mil polyvinyl chloride exterior with 2 mil urethane interior. UL listed and labeled according to Standard UL6; conforming to ETL Verified PVC-001.

D. Liquidtight Flexible Metal Conduit: Spirally wound with hot dip galvanized steel strips as for flexible metal conduit; with polyvinyl chloride cover extruded over the exterior to make conduit liquidtight. UL listed for grounding.

E. Rigid Nonmetallic Conduit: Rigid nonmetallic conduit shall be NEMA TC2, type EPC-40 or EPC-80 PVC high impact, polyvinyl chloride (PVC). Fittings used with PVC conduit shall be PVC solvent weld type. Nonmetallic conduits shall be UL listed for their respective applications. Minimum size shall be 3/4-inch.

1. Exposed or as indicated: Schedule 80.
2. Buried: Schedule 40.

2.2 CONDUIT FITTINGS:

A. Couplings, condulets, and Terminations for GRC: Factory made steel threaded condulets and couplings; bushing at all boxes and cabinets, with locknuts inside and outside box or cabinet. Fittings shall be cast steel with threaded connections.

B. Couplings, condulets, and Terminations for Rigid Aluminum Conduit: Factory made threaded condulets and couplings; bushing at all boxes and cabinets, with locknuts inside and outside box or cabinet. Made from the same material as conduit. Fittings shall be provided with aluminum body with baked aluminum lacquer or epoxy power coating.

C. Couplings, condulets, and Terminations for PVC-Coated Galvanized Rigid Steel Conduit: Factory made condulets and couplings. All condulets, couplings, and other fittings shall be factory fabricated and shall meet the same standards as PVC-Coated Galvanized Rigid Steel Conduit.

D. Couplings and Terminations for Electrical Metallic Tubing (EMT): Join lengths of EMT with steel compression type couplings and connectors. The connectors shall have insulated throats or a smooth interior so as not to damage the insulation during pulling operations.

E. Couplings and Terminations for Liquid Tight Flexible Metal Conduit: T&B 5271 Series adapters at connections between flexible and rigid conduit; T&B 5331 Series nylon insulated throat steel connectors at box or cabinet terminations. Applications where aluminum conduit is specified shall use aluminum connectors.

F. Couplings and Terminations for Rigid Nonmetallic Conduit (PVC): PVC shall be solvent weld by male thread adapter, Schedule 40 or Schedule 80 as required. Other fittings shall be solvent weld connections.

2.3 WIREWAYS:

A. Interior Use: UL listed; enamel finished; sizes shown or required; hinged covers; complete with: all fittings, couplings, hangers and accessories; Universal Hoffman or equivalent.

B. Exterior Use: UL Listed; hot-dip galvanized finish; sizes indicated or required; removable front cover which is gasketed; weatherproof rainhood.

2.4 OUTLET BOXES:

A. UL listed of sizes and types specified.

B. Cast Metal Boxes: Cast iron or cast alloy with threaded hubs; Crouse-Hinds, Appleton, or O.Z./Gedney.

PART 3 EXECUTION

3.1 INSTALLATION OF RACEWAYS:

A. All wiring of every description shall be run in conduit unless noted or specified otherwise. Conduits may be run exposed or concealed as indicated on the drawings. All exposed runs shall be installed parallel and plumb to the surface of the building or structure in a neat and orderly manner.

B. Types: All above grade conduits shall be GRC conduits. Conduits installed below grade in slabs or buried in earth shall be PVC.

C. Transition from below grade PVC to above grade rigid steel shall be before conduit rises out of ground. On conduits larger than 2 inches, use rigid steel elbow. Tape wrap the portion of steel conduit in the ground as specified in Section 16115.

D. Specific conduit material, such as PVC Coated Rigid Steel Conduit may be required for specific areas as indicated on the drawings or specified herein.

E. Installer certification, before installation, is required for PVC-Coated galvanized rigid steel conduit.

F. Sizes: Size and install raceways so that conductors may be drawn in without injury or excessive strain. Make field bends with approved bending devices. Do not install bends or offsets in which conduit is crushed, deformed or otherwise injured. Sizes of conduits shown on the drawings are minimum sizes to be installed. Size conduits per applicable electrical code.

G. Connections: Use lengths of liquid tight flexible metal conduit, not less than 12" long at final connections to all motors, controls, and other devices subject to movement because of vibration or mechanical adjustment.

H. Around Heat Producing Equipment: Wherever possible, avoid installing raceways directly above or in close proximity to heaters and other like objects operating at high temperatures.

I. Joining Rigid Conduits: Join with threaded couplings. Ream out all conduit ends after threading. Secure rigid conduits at panel boxes, junction boxes, pull boxes, switchboards, support boxes, or sheet metal outlet boxes by galvanized locknuts, inside and outside, with insulating bushing inside. Unthreaded set screw type couplings or connectors are not acceptable in rigid conduit systems. No running threads shall be used in conduit systems.

J. Protection of Raceways: Seal ends of all raceways with blank discs ("pennies"), push pennies or other approved closers during construction. Do not pull any conductors into raceways until all plastering and concrete finishing in the vicinity is completed. Swab out all raceways before pulling in conductors.

K. Install blank knock out plugs in all unused openings in boxes, enclosures, or panels.

3.2 CONDUIT SUPPORTS:

A. Support material shall be stainless steel.

B. Support Spacing: Use minimum spacing as directed by National Electrical Code, but space hangers more closely where required by conditions.

C. Supports provided with PVC Coated GRC conduit shall be stainless steel. Galvanized steel supports will not be acceptable.

3.3 INSTALLATION OF OUTLET BOXES:

A. Usage: Provide at each outlet or device of whatever character a metal outlet box in which conduits shall terminate.

B. Boxes for Outdoors: Cast aluminum boxes with gasketed covers.

3.4 INSTALLATION OF PULL AND JUNCTION BOXES:

A. Sizing: Size all pull and junction boxes in accordance with NEC, using larger sizes than required by code where job conditions so indicate.

B. Mounting: Fasten all boxes securely to the building construction, independent of conduit systems. On concealed conduit systems where boxes are not otherwise accessible, set box covers flush with finished surfaces for access.

C. Identification of Pull and Junction Boxes: Each pull and junction box shall be labeled with indelible ink to indicate the wiring contained inside the box. The label shall indicate the panel and circuit number of the wiring contained. The cover plates of boxes serving emergency circuits shall be painted red. Boxes servicing other systems shall be indicated by name.

END OF SECTION

SECTION 16115

UNDERGROUND ELECTRICAL DUCT AND CONDUIT

PART 1 GENERAL

1.1 SECTION INCLUDES:

A. Underground electrical duct and direct burial conduit, together with all other accessories required.

1.2 SUBMITTALS:

A. Submit manufacturer's data on all materials, under provisions of Section 01300.

PART 2 GENERAL

2.1 UNDERGROUND DUCTS:

A. Schedule 40, heavy wall, high impact rigid virgin polyvinyl chloride (PVC) conduit and fittings, conforming to NEMA Publications TC2 and TC3 and UL listed; Carlon or equivalent.

2.2 CONDUITS:

A. Underground PVC Conduit: Schedule 40, heavy wall, high impact rigid virgin polyvinyl chloride (PVC) conduit and fittings, conforming to NEMA Publications TC2 and TC3 and UL listed for direct burial use; Carlon or equivalent.

B. Rigid Steel Conduit: As specified under Raceways and Fittings, Section 16110.

PART 3 GENERAL

3.1 GENERAL:

A. After the affected electrical work has been installed, tested, and approved, backfill all excavations with suitable material. Include the cutting of all sidewalks, streets, and other pavement and repairing the openings in them to return the surface to approximately its original condition.

3.2 EXCAVATIONS:

A. Perform all excavations of every description of whatever substances encountered and to the depths required for installation of the work under this Division.

B. During excavation, stockpile material suitable for backfilling in an orderly manner a sufficient distance from the banks of the trenches to prevent slides or cave-ins. Remove all excavated material not required or suitable for backfill, or waste as directed. Control grading to prevent surface water from flowing into excavations and remove any accumulated water by pumping.

C. Use open cut grading and make trenches of the necessary width for proper installation of the lines with banks as nearly vertical as possible.

D. Grade the bottom of trenches accurately to provide uniform bearing and support for conduit or duct on undisturbed soil at every point along its entire length.

E. Except at locations where excavation of rock from the bottoms of trenches is required, take care not to excavate below the depths required. Where rock excavation is required, remove the rock to a minimum overdepth of 4 inches below the trench depths specified. Backfill the overdepth rock excavation and excess trench excavation to the proper level with sand prior to the installation of conduit or ducts. Whenever wet or otherwise unstable soil that is incapable of properly supporting conduits or ducts is encountered in the trench bottom, remove such soil to a depth required and backfill the trench to trench bottom grade with sand or other suitable material.

3.3 BACKFILLING:

A. Carefully backfill trenches with earth, sandy clay, sand and gravel, or other approved material free from large clods of earth or stone, deposited in thoroughly and carefully compacted 6-inch layers. Do not use blasted rock, broken concrete or pavement, or large boulders as backfill material. Settling the backfill with water will be permissible and will be required when so directed. Re-open any trenches improperly filled or where settlement occurs to the depth required for proper compaction the refill, mound over and smooth off.

B. Backfill open trenches across roadways or other areas to be paved as specified above except that the entire depth of trench shall be backfilled in 6-inch layers, each layer moistened and compacted to a density of not less than 95 percent Standard Proctor in such manner as to permit the rolling and compaction of the filled trench together with the adjoining earth to provide the required bearing valve and permit paving of the area immediately after backfilling is completed. Along all other portions of the trenches, grade the ground to a reasonable uniformity and leave the mounding over the trenches in a uniform and neat condition.

3.4 UNDERGROUND PVC CONDUIT INSTALLATION:

A. Install at least 18 inches below finished grade unless indicated otherwise. Assemble and install raceways in accordance with manufacturer's instructions. Make joints with couplings and solvent cement. Fabricate bends of 30 degrees or more with factory-made elbows, or make field bends with proper heating equipment. Bends showing signs of overheating or flattening are unacceptable. Ream ends of all conduits before joining.

B. "Snake" plastic conduit in trench, from side to side, with a complete cycle every 40 feet to allow for expansion and contraction. Maintain this configuration during backfilling.

C. Where conduit turns up out of earth, or floor slabs, change from plastic to rigid galvanized steel conduit below grade and outside of such structures. Do not extend any plastic conduit above grade. Make similar change from plastic to rigid galvanized steel conduit at connections to underground pull or junction

boxes. Wrap all steel conduits and fittings buried in earth as specified elsewhere herein.

3.5 UNDERGROUND RIGID STEEL CONDUIT INSTALLATION:

A. All rigid galvanized steel conduit exposed to earth shall be wrapped with 3M Company 0.020 inch thick No. 51 "Scotchrap" vinyl plastic tape, half lapped to give double thickness wrap. Remove all oil, grease and dirt from conduit with a suitable solvent, and clean and dry conduit before wrapping. If conduit is pre-wrapped in the shop and then cut and joined on the job, wrap all joints on the job, overlapping pipe wrapping 3" on both sides of joints.

END OF SECTION

SECTION 16120

CONDUCTORS

PART 1 GENERAL

1.1 SECTION INCLUDES:

A. Conductors, together with all splices, connections, and identification, including pulling devices.

1.2 SUBMITTALS:

A. Submit manufacturer's data on all materials, under provisions of Section 01300.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Building wire, power and control cable:

a. Aetna Insulated Wire.
b. Alphawire.
c. General Cable.
d. Okonite Company.
e. Southwire Company.

2. Control Cable:

a. Alphawire.
b. General Cable.
c. Okonite Company.

3. Instrumentation cable:

a. Analog cable:

i. Alphawire.
ii. Belden Inc.
iii. General Cable.

2.2 CONDUCTORS (600 VOLTS AND UNDER):

A. Type: Soft drawn, annealed copper, UL listed, rated at 600 volts, continuous without weld, splice or joint, uniform cross-section, free from flaws, scale and other imperfections; Okonite, Triangle, or Simplex. No. 8 and larger shall be stranded; No. 10 and smaller shall be solid.

B. Insulation: Branch circuits shall have type THHN/THWN or XHHW insulation unless the type is specifically designated or specified. Service feeders shall be

type THHN/THWN or XHHW. Feeder circuits shall be Type THHN/THWN or XHHW.

C. All conductors installed underground or in areas where exposed to damp or wet locations shall be rated THWN or XHHW.

D. Circuits Subjected to High Temperatures: Type XHHW 90 C conductors for wiring in proximity to boilers, and for motors and devices subject to high temperature because of high ambient temperature or convection or radiant heat.

E. Lighting Fixture Conductors: Type and size approved by the NEC for the purpose.

2.3 CONTROL CABLE

A. Reference: UL 83, UL 1277, ICEA S-61-402 (NEMA WC5).

B. Multiconductor cables.

C. Conductor: No. 14 AWG minimum, 7 or 19 strands, concentric-lay, uncoated copper. Maximum operating temperature 90° C.

D. UL listed for use in cable trays.

E. Conductor Insulation: Type THHN/THWN.

F. Shield: None.

G. Cable assembly jacket: Black flame retardant PVC UL 1277, Table 10.17, applied over tape wrapped cable core, rated 600 volts.

H. Factory Tests: Insulated conductors shall conform to the requirements of UL 83 for Type THHN/THWN. Assembly jacket shall meet the requirements of UL 1277. Cable shall conform to the flame test requirements of UL 1277 for Type TC power and control tray cable.

2.4 INSTRUMENT CABLE

A. Reference: UL 2250, UL 1277.

B. The assembly shall be rated 600 volts, 90° C.

C. The assembly shall be UL listed as sunlight resistant, for cable tray use, and shall meet the requirements for types CL2 and CL3 cable.

D. Conductor: No 16 AWG minimum, 7 strand, concentric-lay, uncoated copper

E. Insulation: Polyvinyl chloride. Not less than 15 mils average thickness (13 mils minimum thickness), UL 62, Type TFFN.

F. Lay: Twisted pair or triad with 1-1/2 to 2-1/2 inch lay.

G. Shield: Each pair or triad and cable assemble shall have combination aluminum-polyester helically applied tape and 7 strand AWG minimum size, tinned copper drain wire, shield applied to achieve 100 percent cover over insulated conductor. Shield tape on pair and/or triad assemblies shall be applied in such a way as to give total shield isolation from all other pair or triad shields.

H. Cable assembly: Black flame retardant polyvinyl chloride, UL 1277 applied over tape wrapped cable core.

I. Conductor Identification: Single pair: One conductor black, one conductor white. Single triad: One conductor black, one conductor white, and one conductor red.

J. Factory Tests: Insulated conductors shall conform to the requirements of UL 62 for Type TFFN. Assembly jacket shall conform to the requirements of UL 1277. Cable shall meet the vertical-tray flame test requirements of UL 1277.

2.5 JOINTS AND SPLICES:

A. Stranded Copper Conductors: UL approved tin-plated, copper compression connectors, Thomas & Betts, Panduit, or Burndy. All connectors shall be of proper sizes to match conductor sizes. All compression connectors shall be applied with properly sized dies and tools. Split-bolt connectors are not acceptable.

B. Do not splice control or instrument cables. Instrument or control cables shall only be terminated at devices or on terminal blocks. Conductors may be terminated without compression connector on terminal blocks with appropriate mechanical type terminals. Conductors terminated at terminal blocks with screw terminals shall be terminated with insulated, tin-plated copper locking fork terminals.

C. Solid Copper Conductors: UL approved electrical spring connectors of "Scotchlock", Ideal, T&B, or approved equivalent. All connectors shall be of proper sizes to match conductor sizes. Split bolt connectors are not acceptable.

D. Terminations at 600 volt and lower motors shall use properly sized tin-plated, copper compression connectors on each motor lead and incoming power supply. Connectors shall be bolted together with zinc plated bolt, nut, flat washer, and lock washer. Scotchfil shall be applied to round out the connection and the entire connection shall be wrapped with Scotch 88.

2.6 COLOR CODING:

A. Use standardized color-coding of conductors throughout. All color coding shall be continuous for the entire length of the conductors, and shall be permanent and readily distinguished after installation. In cases where they specified colors of insulated wire and cable are unavailable, such conductors shall be color-coded, as specified above, by means of Brady, or plastic tape at all pull boxes, support boxes, outlet boxes, panelboards, and other terminal and splicing points. Heat shrink sleeves for tight fit.

B. For No. 6 AWG and smaller conductors, color coding shall be provided by using conductors with continuous color imbedded in the insulation. For all conductors larger than No. 6, Scotch 35 marking tape, or equivalent may be used to color code the cable. Where marking tape is used, the cable shall be identified at every accessible location. Provide a minimum of 2 inches of tape at each location.

C. Neutral conductors shall be white or natural gray. Grounding conductors shall be green or green with one or more yellow stripes.

D. Conductors shall be black, red and white for lines 1, 2 and neutral respectively in the 240/120 volt system.

E. Phase conductors shall be brown, orange, and yellow for phases A, B, and C respectively in the 480 volt system.

F. Color coding for multi conductor control circuits shall conform to ICEA Method 1, Table E-2.

PART 3 EXECUTION

3.1 CONTINUITY:

A. All conductors shall be continuous between points of termination.

B. Splices between points of termination are not acceptable unless specifically approved.

C. Splices in boxes permissible in 120-volt lighting and receptacle circuits only.

3.2 WIRE PULLING:

A. Provide suitable installation equipment for pulling conductors into raceways or conduits. Use ropes of polyethylene, nylon or other suitable material to pull in conductors. Attach pulling lines to conductors by means of woven basket grips or by pulling eyes attached directly to conductors. Grips and pulling eyes shall be Kellems or equivalent. All conductors to be installed in a single conduit shall be pulled in together. Pull no conductors into conduits until all work of a nature which may cause injury to conductors is completed. Use cable pulling compound where necessary.

B. Cable Lubricants: All cable lubricants shall be UL listed, and shall be certified by their manufacturer to be non-injurious to the insulation on which they are used.

C. Pulling Devices in Empty Raceways: Provide in every empty raceway, not containing conductors to be installed by this Contractor, a suitable pull line to facilitate future installation of wiring. Lines shall be free from splices and shall have ample exposed length at each end. Identify each end of each line with a linen tag bearing complete information as to the purpose of the raceway and the location of its other end. All lines shall be nylon or polyethylene cord with a tensile strength not less than 200 pounds.

3.3 WIRE INSTALLATION (600 VOLTS AND UNDER):

A. Feeders: Run all feeders their entire length in continuous pieces without joints or splices, insofar as practicable. Make joints in branch circuits only where circuits divide as shown on drawings. Such joints shall consist of one through circuit to which shall be spliced the tap circuit.

B. Branch Circuits: Not more than one power or lighting circuit shall be installed in a single conduit, except that one 3-wire circuit or one 4-wire circuit consisting of 2 different phase wires and a common neutral or 3 different phase wires and a common neutral may be installed in a single conduit. This provision shall not prohibit the installation in a single conduit of all conductors of a circuit with three and four-way switching.

C. Sizes: No wire shall be smaller than No. 12 except for control circuits.

D. Joints and Splices: Only receptacle and lighting circuits will be allowed to be spliced. Make joints and splices in solid copper conductors only where necessary and only at outlet boxes and pull boxes. All joints shall be mechanically and electrically secure.

E. Identity Tags: Non-ferrous; stamped to clearly identify each circuit. Securely fasten tags to all cables, feeders and power circuits in pull boxes, lighting, power and distribution panelboards, etc.

F. Bundling Conductors: Bundle all conductors in panelboards, cabinets and the like using nylon straps made for the purpose. Bundle conductors larger than No. 10 in individual circuits. Bundle smaller conductors in larger groups. Straps shall be Panduit, Thomas and Betts, or equivalent.

END OF SECTION

SECTION 16140

WIRING DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES:

A. Suitable outlet boxes, with the wiring devices indicated, coverplates, etc. All shall be properly connected to conductors so as to be operable.

1.2 SUBMITTALS:

A. Submit manufacturer's data on all materials, under provisions of Section 01300.

PART 2 PRODUCTS

2.1 MATERIALS:

A. Acceptable Manufacturers: The catalog numbers listed herein are generally of Hubbell manufacture. Equivalent devices of Arrow-Hart, Pass and Seymour, or Leviton are acceptable.

B. Classification: All wiring devices shall be "Specification Grade", and shall be UL listed.

C. Colors: All devices shall have an ivory finish where mounted in walls finished in light colors and a brown finish where mounted in walls finished in dark colors.

2.2 WALL SWITCHES:

A. Provide the following 120/277 volt switches:

Device	Hubbell Catalog No.
Single pole wall switch	1221

2.3 RECEPTACLES:

A. Receptacle, 20-ampere, 125-volt, 2-pole, 3-wire grounding duplex: Hubbell No. 5362.

B. Receptacle, 20-ampere, 125-volt, 2-pole, 3-wire Grounding Duplex with Self-contained Ground Fault Circuit Interrupter: Hubbell No. GF 5362 (NEMA 5-20R).

C. Other receptacles as indicated on the drawings.

2.4 OTHER DEVICES:

A. Weatherproof Devices: Provide the specified device in FD box with a weatherproof cover that meets the requirements of NEC Article 406.8(B). Cover shall be cast metal equal to Intermatic, Incorporated. Simplex or duplex, vertical or horizontal as indicated.

B. Provide coverplates for all wiring devices, telephone, signal outlets and other kindred devices.

C. Provide galvanized or cast cover for surface mounted boxes.

PART 3 EXECUTION

3.1 CIRCUIT IDENTIFICATION:

A. At each wiring device, install a label on the inside of the coverplate which shall identify the panel and circuit number to which the device is finally connected. The labels shall be made on the job with indentation-type Dynamo adhesive tape. Attach the label to the plate with contact cement or other suitable adhesive material. In lieu of a label, the panel and circuit number may be neatly marked on the inside of the coverplate with an indelible pencil.

3.2 MOUNTING HEIGHTS:

A. Where mounting heights are indicated on the drawings, the device shall be installed with the centerline of the device at the indicated height.

B. Unless otherwise noted on the drawings, or directed, install device at the following heights:

Device	Mounting Height
Wall Switch	54"
Exposed receptacles	36“

END OF SECTION

SECTION 16170

CIRCUIT AND MOTOR DISCONNECTS

PART 1 GENERAL

1.1 SECTION INCLUDES:

A. This Section specifies circuit and motor disconnect switches for general use.

1.2 SUBMITTALS:

A. Provide complete catalog data and drawings on all items of equipment, under provisions of Section 01300. Include all submittal data in the operation and maintenance manuals.

PART 2 PRODUCTS

2.1 DISCONNECT SWITCHES:

A. Unless otherwise noted or required, all disconnect switches shall be UL listed and shall meet the latest edition of NEMA Standard KS1 for Type HD heavy duty switches. Unless indicated otherwise on the drawings, switches shall be unfused; quick make, quick break; in NEMA 4X stainless steel enclosures. All motor circuit switches shall be horsepower rated.

B. Switches shall be of General Electric, Eaton, or Square D manufacture, equivalent to General Electric Type TH quick make, quick break switches.

C. Additional disconnect switches may be identified on the drawings. If so identified, provide the type called for on the drawings.

PART 3 EXECUTION

Not used.

END OF SECTION

SECTION 16195

ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.1 SECTION INCLUDES:

A. This Section specifies furnishing and installing identification signs on all electrical devices.

PART 2 PRODUCTS

2.1 NAMEPLATES:

A. Identify electrical equipment by attaching engraved nameplates constructed from laminated phenolic plastic, at least 1/16" thick, 2-ply, with black surfaces and white core. Engraving shall be condensed gothic, appropriately spaced. Nomenclature on the label shall include the name of the item or equipment served utilizing the equipment names shown on the drawings.

B. Nameplate lettering size shall be as follows:

1. ½" Minimum Height Letters:

Service Disconnects.

a. Secondary feeder breakers in distribution equipment with designation as required by the load served.

b. Special equipment housed in cabinets, as indicated on the drawings, or outside of door.

c. Panelboards, switchboards, as designated on the drawings, on outside of door.

2. 1/4" Minimum Height Letters:

a. Disconnects and starters for motors or fixed appliances.

b. Items listed in the “Equipment Schedule” on drawings.

3. 1/8" Minimum Height Letters:

a. Engraved black filled letters on devices plates for switches, dimmer controls, and receptacles where item controlled is not visible from switch, or as indicated on the drawings.

PART 3 EXECUTION

3.1 EQUIPMENT:

A. Install nameplates on electrical equipment. Equipment to be labeled shall include but not be limited to the following:

1. Panelboards.
2. Dry-type transformers.

3.2 CONTROL DEVICES:

A. Label all electrical control devices to indicate the device served. Label electrical control devices regardless of proximity to the equipment served. Electrical control devices to be labeled shall include but not be limited to the following.

1. Relays.
2. Relay panels.
3. Disconnect switches.

3.3 ATTACHMENT:

A. Nameplates attached to the exterior of the enclosure shall be attached with self-tapping screws. Devices attached to the back side of panel fronts and on the interior of panels shall be attached with adhesive. Adhesive shall be waterproof and heat resisting up to 250 degrees Fahrenheit.

END OF SECTION

SECTION 16400

ELECTRICAL SERVICES

PART 1 GENERAL

1.1 SECTION INCLUDES:

A. The complete electrical service from the power company service point to the service entrance equipment, including all electric utility required modifications, whether primary or secondary. This shall include all poles, primary conductors, secondary conductors, transformers, metering equipment, or other equipment that might be required for the electric utility to extend or provide electric service to new Sulphur Draw lift station.

B. All costs associated with providing electrical service to the new facilities shall be included in the contractor's bid price, whether due to equipment or services provided by the electric utility or the Contractor. Contractor shall coordinate with the local electric utility to determine all costs and requirements associated with providing service to the new facilities. Failure by the Contractor to fully investigate all aspects of the requirements for electrical and telephone service prior to submitting a bid shall not be grounds for a change order.

C. The electric utility representative is Clay Gibson with AEP and the local contact is 325-650-1323.

D. The communications representative is William Gatlin with Frontier Communications and the local contact 325-949-7667

1.2 SUBMITTALS:

A. Submit for review catalog data and drawings for all equipment proposed for use under this Section, under provisions of Section 01300.

B. Submit reports of load balancing between phases.

1.3 NEW SERVICES

A. Contractor shall arrange and pay for the installation of new electrical services as indicated. This shall include making contact with the electric utility representative. All outages required during the project construction shall be coordinated by the contractor. Electrical metering equipment shall be provided and installed by the electrical utility. Meter bases and all other equipment indicated on the drawings or required by the electric utility shall be provided and installed by the contractor.

B. Communications service shall be provided as indicated on the drawings or required by the telephone company.

C. The electrical service billing will be through the City of San Angelo Collections Department.

PART 2 PRODUCTS

2.1 UNDERGROUND DUCTS:

A. As specified in Section 16115.

2.2 UNDERGROUND PLASTIC CONDUIT:

A. As specified in Section 16115.

2.3 METERING:

A. All metering for Power Company billing will be done by metering equipment furnished and installed by the Power Company.

B. Contractor shall provide meter bases, enclosures, and other equipment as required by the electric utility.

2.4 SYSTEMS OF WIRING:

A. Electrical Service: Combined 480/277 volts, 3-phase, 4 wire, 60 Hz. service for lighting and power.

B. Power Feeders: 480 volts, 3-phase, 3 or 4 wire as noted.

C. Receptacle and lighting Feeders: 240/120 volts, 1-phase, 3 wire.

D. Branch Circuits: 2, 3, or 4-wire as is most convenient for the contractor, or as required to properly serve the load.

2.5 LOAD BALANCING:

A. The contractor shall balance electrical loads between the various phases. When the facilities are under use at their heaviest loading periods, tests shall be run on the "hot" conductors in each feeder to a panel and any unbalances shall be corrected to a point that no conductor load shall be more than 5 percent high or low (maximum unbalance of 10 percent) in amperes. Submit reports of load balancing.

PART 3 EXECUTION

3.1 EXCAVATION AND BACKFILLING:

A. As specified under RACEWAYS AND FITTINGS.

3.2 UNDERGROUND DUCTS INSTALLATION:

A. Install as specified under UNDERGROUND ELECTRICAL DUCTS.

3.3 UNDERGROUND PLASTIC CONDUIT INSTALLATION:

A. Install as specified under UNDERGROUND ELECTRICAL DUCTS.

END OF SECTION

SECTION 16450

GROUNDING

PART 1 GENERAL

1.1 SECTION INCLUDES:

A. Grounding systems as specified and in accordance with the National Electrical Code.

1.2 SUBMITTALS:

A. Submit manufacturer's data on all products, under provisions of Section 01300.

1.3 QUALITY ASSURANCE:

A. Comply with applicable sections of Article 250 of the NEC and local amendments.

B. Provide products specified in the Section that are listed and labeled by a nationally recognized testing laboratory.

C. Install products that comply with UL 467, “Grounding and Bonding Equipment.”

PART 2 PRODUCTS

2.1 GROUNDING AND BONDING PRODUCTS:

A. Install types indicated and of sizes and ratings to comply with NEC. Where types, sizes, ratings, and quantities indicated are in excess of NEC requirements, the more stringent requirements and the greater size, rating, and quantity indications shall govern.

B. Conductor Material: Copper.

2.2 WIRE AND CABLE CONDUCTORS:

A. Equipment Grounding Conductor: Bare or green insulated. Minimum size No. 12 AWG.

B. Grounding Electrode Conductor: Class B, concentric stranded.

1. Bare Copper conductors: Conform to the following:

a. Solid Conductors: ASTM B-3.
b. Stranded Conductors: ASTM B-8.
c. Tinned Conductors: ASTM B-33.

2.3 MISCELLANEOUS CONDUCTORS:

A. Ground Bus: Bare annealed copper bars of rectangular cross section.

B. Braided Bonding Jumpers: Copper tape, braided No. 30 gage bare copper wire, terminated with copper ferrules.

C. Bonding Strap Conductor/Connectors: Soft copper, 0.05 inch thick and 2 inches wide, except as indicated.

2.4 CONNECTOR PRODUCTS:

A. Listed and labeled as grounding connectors for the materials used.

B. Connector Material: Copper or bronze.

C. Pressure Connectors: High conductivity plated units.

D. Bolted Clamps: Heavy duty units listed for the application.

E. Exothermic Welded Connections: Provided in kit form and selected for the specific types, sized, and combinations of conductors and other items to be connected.

2.5 GROUNDING ELECTRODES:

A. Copper clad steel 5/8"X8' with high-strength steel core and electrolytic-grade copper outer sheath, molten welded to core.

PART 3 EXECUTION

3.1 SERVICE AND EQUIPMENT GROUNDING:

A. Provide adequate and permanent service neutral and equipment grounding in accordance with the National Electrical Code, and subject to the following additional requirements.

B. Connect the service ground and equipment ground to a common point within the metallic enclosure containing the main service disconnecting means. From the common point of connection of the service ground and equipment ground, run in conduit a combined service and equipment grounding conductor without joints or splices to the grounding grid as shown. Grounding grid shall be constructed of 8 feet long by 5/8 inch diameter copperclad steel ground rods with buried grounding conductors as indicated on the drawings.

C. Size grounding conductors in accordance with National Electrical Code Tables 250.66 and 250.122 or as indicated.

D. The building structural steel frame shall be grounded to the building service grounding electrode, using the conductor size specified in National Electrical Code Section 250.66.

E. Provide additional connections as may be required by the local authority. Contractor shall contact the local authority prior to bidding. Any additional connections that may be required by the local authority shall be provided by the Contractor at no increase in the bid price.

3.2 GROUNDING RACEWAYS:

A. Assure the electrical continuity of all metallic raceways systems, pulling up all conduits and/or locknuts wrench tight. Where expansion joints or telescoping joints occur, provide bonding jumpers. Where flexible metallic conduit is employed, provide a green-insulated grounding jumper installed in the flexible conduit. Install a separate green-insulated conductor in each conduit.

B. Provide grounding bushings on all service and feeder raceways terminating within switchboards, motor control centers, panel boards, cabinets, and all other enclosures. Provide grounding conductors from such bushings to the frame of the enclosure and to the ground bus or equipment grounding strap. Size grounding conductors in accordance with NEC Table 250.122.

3.3 EQUIPMENT GROUNDING CONDUCTORS:

A. Provide a separate, green-insulated equipment copper grounding conductor, with insulation of the same rating as phase conductors, for each feeder and for each branch circuit indicated. Install the grounding conductor in the same raceway with the related phase and neutral conductors, and connect the grounding conductor to pull boxes or outlet boxes at intervals of 100 feet or less. Where paralleled conductors in separate raceways occur, provide a grounding conductor in each raceway. Connect all grounding conductors to bare grounding bars in panel boards, and to ground buses in service equipment to the end that there will be an uninterrupted grounding circuit from the point of a ground fault back to the point of connection of the equipment ground and system neutral. Size all of these grounding conductors per NEC Table 250.122.

3.4 UNDERGROUND CONNECTIONS:

A. All underground connections shall be made using exothermic weld connections.

3.5 GROUNDING DRY-TYPE TRANSFORMERS:

A. Ground the secondary neutral point and the housing of each dry-type transformer. Connect these items together within the transformer housing and run a common grounding conductor from their point of connection to a point of grounding. The grounding electrode shall be in order of preference:

1. The nearest available effectively grounded structural metal member of the building; or

2. Other electrodes as specified in National Electrical Code Section 250.30 where the above described electrodes are not available.

END OF SECTION

SECTION 16470

PANEL BOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES:

A. Electrical panel boards for general use.

1.2 SUBMITTALS:

A. Provide complete catalog data and drawings on all items of equipment, under provisions of Section 01300. Include all submittal data in the Operation and Maintenance Manuals.

B. Submit shop drawings of each panel board for review before commencing fabrication; drawings shall indicate number, size, interrupting rating and type of circuit protective devices; dimensions, gauges and type of construction of cabinets; size and material of main bus and lugs; and any other pertinent information necessary to determine compliance with the drawings and specifications.

1.3 QUALITY CONTROL:

A. All panel boards shall be listed by Underwriters' Laboratories, Inc., and the building main panel shall be listed as suitable for "Service Entrance Equipment."

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Panel boards manufactured by Square D, General Electric, Siemens, or Eaton.

2.2 PANEL BOARDS:

A. Panel board Cabinets: Furnish and install cabinets to serve the various panel boards, of sizes as required to house the panel boards. Provide NEMA rated enclosure as indicated on the drawings.

B. Service Equipment Approval: Listed for use as service equipment for panelboards having main service disconnects.

C. Panel boards indicated to be provided with a NEMA 4X enclosure shall be provided with a stainless steel enclosure.

D. Cabinet Construction: Rigidly constructed of sheet steel of gauges conforming to Underwriters' Laboratories, Inc., requirements; corners overlapped or welded; edges turned over to receive trim.

E. Each panel board shall be provided with a cover and a hinged door. Each door shall be provided with a substantial flush, cylinder tumbler lock and catch. On

doors more than 48" high, provide a combination three point catch and lock with T-handle. Provide each lock with two keys, with all locks keyed alike.

F. Bus Requirements:

1. Bus Material: Copper.

2. Panel boards with buses rated 600 ampere and above shall be provided with silver-plated hard-drawn copper.

3. Main and Neutral Lugs: Mechanical.

4. Neutral: Ampacity and material equal to bus. Panelboards shall be provided with insulated neutral bars with grounding screw for field grounding to enclosure.

5. Equipment Ground Bus: Provide each panel board with a separate equipment grounding bus bar bonded to the panel board cabinet. Where indicated on the drawings, provide panel boards with an isolated grounding bus bar insulated from the panel board cabinet.

G. Additional requirements for subfeed breakers, lugs, or other accessories as indicated on the drawings.

H. Where a circuit protective device is scheduled as a "spare", provide the device complete for operation. Where such a device is scheduled as a "space" or "space only", provide proper space and all necessary connectors for future installation of the size of device scheduled. Where a breaker or switch is scheduled to serve a "future" load, provide the device complete for operation.

I. Panel boards shall have the number and sizes of bolted-in circuit breakers scheduled on the drawings with main circuit breakers or lugs only on the mains as scheduled.

J. All circuit breakers shall be fully rated for the current interrupting rating as indicated on the drawings, or at a minimum, as follow:

VOLTAGE RATING	INTERRUPTING RATING
120/240 Volts	10,000 Amps
277 Volts	42,000 Amps
480 Volts	42,000 Amps

K. All circuit breakers shall be quick make, quick break, trip free, thermal magnetic, indicating type unless noted otherwise. Provide all multiple pole breakers with common trip and single operating handle; handle ties between breakers are unacceptable. Branch circuit breakers shall be fully interchangeable without disturbing adjacent units.

L. Connect all circuit interrupting devices with sequence phasing.

M. Where a feeder serves more than one panel, first entering one panel and then proceeding through a side gutter to other panels, install the feeder full size in a continuous piece without joint or splice through the side gutter of the panels to serve the succeeding panels. Make the gutters on that side and on the top at least 4" greater than normal (more if necessary) to accommodate the wiring and make the tap from the feeder to the panels with suitable bolted pressure T-cable top connectors. Under no circumstances use feed-through lugs on a panel bus with the current drawn by a panel being carried through the buses of the preceding panel.

N. Finish: All back boxes galvanized; all exposed metal, including fronts, primed and finished in gray lacquer.

O. Mount all panel boards in cabinets as specified hereinbefore, arranged for flush or surface mounting as indicated on drawings.

P. Provide each panel board with a neatly typewritten directory of circuits mounted in a cardholder on the inside of the panel board cabinet. Cover directory with transparent sheet plastic.

Q. Provide each panel board with a factory engraved nameplate which shall identify the panel board name and voltage.

PART 3 EXECUTION

3.1 Install panel boards in accordance with manufacturer's instructions and as specified or shown.

3.2 Test all elements of panel board with 1000-volt insulation resistance tester before energizing. Insulation resistance less than 50 megaohms is unacceptable.

END OF SECTION

SECTION 16491

AUTOMATIC TRANSFER SWITCH

PART 1 GENERAL

1.1 SECTION INCLUDES:

A. Automatic transfer switch (ATS), 480-volt, 3-phase for standby power service.

B. The automatic transfer switch supplier shall be provided by the packaged engine-generator supplier, in accordance with Section 16620, to ensure one source of responsibility.

1.2 STANDARDS:

The automatic transfer switches and controls shall conform to the requirements of the following:

A. IEC 60947-6-1 Low-voltage Switchgear and Control gear; Multifunction equipment; Automatic Transfer Switching Equipment.

B. NFPA 70 - National Electrical Code.

C. NFPA 110 - Emergency and Standby Power Systems.

D. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.

E. NEMA Standard ICS10 (formerly ICS2-447) - AC Automatic Transfer Switches.

F. UL 508 Industrial Control Equipment.

G. UL 1008 - Standard for Transfer Switch Equipment.

1.3 SUBMITTALS:

A. Submit in accordance with 01300.

1.4 SERVICE REPRESENTATION:

The ATS manufacturer shall maintain a national service organization of company-employed personnel located throughout the contiguous United States. The service center's personnel shall be factory trained and on call 24 hours a day, 365 days a year. ATS manufacturer shall utilize technicians that are dedicated solely to switchgear and ATS maintenance and repair. ATS technicians shall arrive onsite in vehicle dedicated to repair and parts replacement of electrical switchgear and transfer switches.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURER:

A. The listed manufacturer below shall actually manufacture the transfer switches for this project. Companies that simply purchase switches and/or components or "rebrand" other manufacturers products are specifically prohibited. The engine generator set supplier shall provide specified automatic transfer switch to ensure one source of responsibility.

B. Manufacturers:

1. ASCO.
2. Russell.
3. Approved equivalent.

2.2 TRANSFER SWITCH EQUIPMENT:

A. Each automatic transfer switch shall consist of an inherently double throw power transfer switch mechanism and a microprocessor controller to provide automatic operation. All automatic transfer switches and controllers shall be the products of the same manufacturer.

B. Automatic transfer switch shall be 3-pole with solid neutral and ground bar, or as indicated on the drawings.

C. All transfer switch sizes shall use only one type of main operator for ease of maintenance and commonality of parts.

D. Ampacity shall be as indicated on the drawings.

E. Each complete factory-assembled automatic transfer system shall have the following features: electronic control designed for surge voltage isolation with voltage sensors on all phases of both sources; linear operator; permanently attached manual handles; positive mechanical and electrical interlocking; and mechanically-held contacts.

F. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources will not be acceptable.

G. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. Switches rated 800 amps and higher shall have front removable and replaceable contacts. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.

H. The switch shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.

I. The ATS shall be UL listed in accordance with UL 1008 and be labeled in accordance with that standard's 0.025 and 0.05 second, time based ratings. ATS which are not tested and labeled with time based ratings and have series, or specific breaker ratings only, are not acceptable.

J. Provide transfer switch according to the following:

1. Transfer switch shall be rated to carry 100 percent of rated current continuously in the enclosure. Circuit breaker-type transfer switches are not acceptable.

2. Transfer switches shall be continuously rated in ambient temperatures of -40 to +50 degrees C, relative humidity up to 95 percent (non-condensing), and altitudes up to 10,000 feet.

3. Transfer switch equipment shall have a withstand and close-on rating (WCR) in RMS symmetrical as indicated on the drawings.

4. Construction: Transfer switches shall be double-throw, electrically and mechanically interlocked, and mechanically-held in both positions.

5. Transfer switches shall be equipped with manual operators for use only under de-energized conditions.

6. Main switch contacts shall be high-pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishment. Arc chutes shall have insulating covers to prevent interphase flashover.

7. Provide two sets of Form C auxiliary contacts on both sides, operated by transfer switch positions, rated 10 amp 250 VAC.

2.3 ENCLOSURE:

A. Enclosure shall be NEMA 4X, unless otherwise indicated.

B. All standard and optional door-mounted switches and pilot lights shall be 16-mm industrial grade type or equivalent for easy viewing & replacement. Door controls shall be provided on a separate removable plate.

2.4 AUTOMATIC CONTROLS:

Control shall be solid-state and designed for a high level of immunity to power line surges and transients, demonstrated by test to IEEE Standard 587. The control shall have optically isolated logic inputs, high isolation transformers of AC inputs, and relays on all outputs.

A. Solid-state under-voltage sensors shall simultaneously monitor phases of both sources. Pick-up and drop-out settings shall be adjustable. Voltage sensors shall allow for adjustment to sense partial loss of voltage on any phase. Voltage sensor shall have field calibration of actual supply voltage to nominal system voltage.

B. Automatic controls shall signal the engine-generator set to start upon signal from normal source sensors. Solid-state time-delay start, adjustable from 0 to 15 seconds (factory-set at 2 seconds) shall avoid nuisance start-up. Battery voltage starting contacts shall be gold, dry-type contacts factory-wired to a field wiring terminal block. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output, and run for the duration of the cool down setting, regardless of whether the normal source restores before the load is transferred.

C. The switch shall transfer when the emergency source reaches the set point voltage and frequency. Provide a solid-state time delay on transfer, adjustable from 0 to 120 seconds.

D. The switch shall retransfer the load to the normal source after a time delay retransfer, adjustable from 0 to 30 minutes. Retransfer time delay shall be immediately bypassed if the emergency power source fails.

E. Controls shall signal the engine-generator set to stop after a time delay, adjustable from 0 to 10 minutes, beginning on return to the normal source.

F. Power for transfer operation shall be from the source to which the load is being transferred.

G. The control shall include latching diagnostic indicators to pinpoint the last successful step in the sequence of control functions, and to indicate the present status of the control functions in real time, as follows:

1. Source 1 OK.
2. Start Gen Set.
3. Source 2 OK.
4. Transfer Timing.
5. Transfer Complete.
6. Retransfer Timing.
7. Retransfer Complete.
8. Timing for Stop.

H. The control shall include provisions for remote transfer inhibit and area protection.

I. Front Panel Devices: Provide devices mounted on cabinet from consisting of:

1. A key-operated selectors switch to provide the following positions and functions:

   a. Test--Simulates normal power loss to control for testing of generator set. Controls shall provide for a test with or without load transfer.

   b. Normal--Normal operating position.

   c. Retransfer--Momentary position to override retransfer time delay and cause immediate return to normal source, if available.

J. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance. Sensing and control logic shall be provided on multi-layer printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers. The panel shall be enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance. The protective cover shall include a built-in pocket for storage of the operator's manuals.

The control panel shall be at minimum 4 lines, 20 character and shall give user clear indication of the status of the transfer switch. Control panel shall track and store the last 99 events.

K. The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:

1. EN 55011:1991: Emission standard - Group 1, Class A.
2. EN 50082-2:1995: Generic immunity standard, from which:

    a. EN 61000-4-2:1995 Electrostatic discharge (ESD) immunity.
    b. ENV 50140:1993 Radiated Electro-Magnetic field immunity.
    c. EN 61000-4-4:1995 Electrical fast transient (EFT) immunity.
    d. EN 61000-4-5:1995 Surge transient immunity.
    e. EN 61000-4-6:1996 Conducted Radio-Frequency field immunity.

2.5 TIME DELAYS:

A. An adjustable time delay of 0 to 6 seconds shall be provided to override momentary normal source outages and delay all transfer and engine starting signals. Capability shall be provided to extend this time delay to 60 minutes by providing an external 24 VDC power supply.

B. A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads to emergency.

C. Two time delay modes (which are independently adjustable) shall be provided on re-transfer to normal. One time delay shall be for actual normal power failures and the other for the test mode function. The time delays shall be adjustable from 0 to 60 minutes. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.

D. A time delay shall be provided on shut down of engine generator for cool down, adjustable from 0 to 60 minutes.

E. A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minute time delay in any of the following modes:

1. Prior to transfer only.
2. Prior to and after transfer.
3. Normal to emergency only.

4. Emergency to normal only.
5. Normal to emergency and emergency to normal.
6. All transfer conditions or only when both sources are available.

F. The controller shall also include the following built-in time delays for optional Closed Transition and Delayed Transition operation:

1. 1 to 5 minute time delay on failure to synchronize normal and emergency sources prior to closed transition transfer.

2. 0.1 to 9.99 second time delay on an extended parallel condition of both power sources during closed transition operation.

3. 0 to 5 minute time delay for the load disconnect position for delayed transition operation.

G. All time delays shall be adjustable in 1 second increments, except the extended parallel time, which shall be adjustable in .01 second increments.

H. All time delays shall be adjustable by using the LCD display and keypad or with a remote device connected to the serial communications port.

2.6 ACCESSORY ITEMS:

A. Transfer switches shall be equipped with accessories as follows:

1. Provide solid-state exerciser clock to set the day, time, week and duration of generator set exercise/test period. Provide a with/without load exercise period selector switch. At the end of the specified duration the switch shall transfer the load back to normal and run the generator for the specified cool down period. A 10-year life battery that supplies power to the real time clock in the event of a power loss will maintain all time and date information.

2. Exercise clock.

3. Programmed transition.

4. Over Voltage and Over/Under frequency sensing for normal source and emergency source.

5. Ground bar.

PART 3 EXECUTION

3.1 INSTALLATION:

A. Installation shall comply with NEC and National Fire Code. Install equipment in accordance with manufacturer's instruction and instructions included in the listing or labeling of UL listed products.

B. Prior to equipment's being energized, a factory representative shall inspect installation and issue to Owner and Engineer a certificate of proper installation.

3.2 FACTORY TESTS:

A. Provide a factory-certified record of the production testing.

1. The complete ATS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.

2. The ATS manufacturer shall be certified to ISO 9001 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001.

3. Factory tests shall include a complete functional test of transfer switch controls, including calibration of the voltage sensors.

3.3 FIELD TEST:

A. Responsible party under Specification Section 16620 shall demonstrate transfer switch operation with field tests of engine-generator system.

END OF SECTION

SECTION 16620

PACKAGED ENGINE GENERATOR SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES:

A. One complete and operable standby engine generating system, including devices and equipment specified and shown. Equipment shall be new, factory-tested, and delivered ready for installation. If necessary, standard equipment or systems shall be modified to provide the specified features.

B. Generator size indicated on the drawings has been selected based on information available. Contractor shall submit documentation that the generator provided by the Contractor is adequate to start and run the required loads with no more than a 30% voltage drop on starting.

C. The packaged engine-generator supplier shall provide the automatic transfer switch, in accordance with Section 16491, to ensure one source of responsibility.

1.2 SUBMITTALS:

A. Submit in accordance with Section 01300.

B. Submit the following:

1. Specification and data sheets.

2. Manufacturer's certification of prototype testing.

3. Manufacturer's published warranty documents.

4. Shop Drawings showing plan and elevation views with certified overall and interconnection point dimensions.

5. Weatherproof sound enclosure drawings.

6. Fuel tank drawings.

7. Interconnection wiring diagrams showing external connections required; with field wiring terminals marked in a consistent point-to-point manner.

8. Manufacturer's installation instructions.

9. Operation and maintenance materials for the overall system as well as all individual components.

1.3 WARRANTY:

A. Provide warranty directly to the Owner for standby power generator system against defects in materials and workmanship, for one-year period from the start-up date and per the manufacturer's Base Coverage Limited Warranty. Warranty shall include labor. This will not relieve the Contractor for his warranty.

B. Provide the supplier's name, address, and phone number to Owner. Supplier shall have 24-hour availability and factory-trained service technicians authorized to do warranty service on all warrantable products.

1.4 QUALITY ASSURANCE:

A. Provide initial start-up services, conduct field acceptance testing, and warranty service.

B. Provide units that conform to the following standards:

1. UL2200.
2. NFPA 110, Level 2.
3. Environmental Protection Agency (EPA) nonroad emissions regulations.

PART 2 PRODUCTS

2.1 MANUFACTURER:

A. The single party identified for overall responsibility below shall assume full, single-party responsibility for the complete engine-generator-transfer switch system. This party shall provide all engineering, manufacturing, installation, checkout, maintenance, training, and other work necessary for a complete and operable system.

B. Specific Suppliers:

Engine Manufacturer	Generator Manufacturer	Overall Responsibility
Cummins	Onan	Cummins-Onan
John Deere, Volvo, Detroit, and Mitsubishi	Kohler	Kohler Systems.
Caterpillar	Caterpillar	Caterpillar
Approved Equivalent	Approved Equivalent	Approved Equivalent

2.2 RATINGS:

A. Generator set rating:

1. 50 kW.
2. 62.5 kVA at 0.8 PF.
3. Standby rating.

B. System voltage:

1. 277/480 WYE Volts AC.
2. Three-phase.
3. Four-wire.
4. 60 hertz.

C. Performance:

The generator shall be capable of starting and operating one pump motor, size as indicated on the drawing and specified, operated by a solid state soft starter, with 10 kW of single step, step one auxiliary load. The generator size specified shall be the minimum size accepted. The Contractor shall verify that the generator size specified will start and operate the specified motor, with the auxiliary load in service, prior to submitting a bid. If the specified unit will not successfully operate the motor with the auxiliary load, the Contractor shall increase the size of the generator. If the generator kW rating is required to be increased after the bid is submitted, the Contractor shall increase the generator kW at no increase in bid price.

D. Site conditions:

1. Altitude: 1,800 ft.
2. Temperatures up to 115 degrees F.

2.3 DIESEL ENGINE-GENERATOR SET:

A. Type: Outdoor-housed type, 4-cycle, 1800 rpm, diesel engine generator set with low reactance brushless generator, torque-matched excitation, 3-phase RMS sensing automatic voltage regulator, system. Generator shall have overcurrent and overload protection in accordance with NEC Article 445.12. This protection shall be a main circuit breaker.

B. Enclosure: Provide an outdoor, sound attenuated, weatherproof enclosure as specified below.

1. Maximum full load sound level shall not exceed 75 dBA at 7 meters from the enclosure. Housing shall be ventilated with adequate space provided for access to filters and strainers and for other servicing. Sufficient clearance shall be provided between the housing and the unit on both sides and generator end to prevent outside precipitation from getting on the instrument panels and generator during operation of the unit. Insect screens shall be provided over all ventilation openings. Housing door shall have a lockset or shall have padlocking provisions.

2. Number of doors on the enclosure shall be as required so that all normal maintenance operations, such as lube oil change, filter change, belt adjustment and replacements, hose replacements, access to the control panels, etc., may be accomplished without disassembly of any enclosure components. Access doors shall be fabricated of the same material as the enclosure walls and shall be

reinforced for rigidity. Handles shall be key lockable, all doors keyed alike, and hinges and hardware shall be stainless steel.

3. Enclosure shall be painted with powder baked paint.

4. Air handling shall be sized and designed by the manufacturer for 0.5" static pressure drop through the enclosure. Intake openings shall be screened to prevent the entrance of insects and rodents. The system shall include a cooling and combustion air inlet silencer system, and equipment enclosure section, and a cooling air discharge silencer section.

5. Lube oil and coolant drains shall be extended to the exterior of the enclosure and terminated with drain valves and capped with pipe nipples on flanged connectors. Radiator access shall be through a hinged, lockable cover on the enclosure. Cooling fan and charging alternator shall be fully guarded to prevent injury.

6. Internally mounted critical type silencer, companion flanges, and flexible stainless steel exhaust fitting properly sized shall be furnished. Enclosure manufacturer shall internally mount the exhaust silencer and maintain the weather resistant integrity and aesthetic appearance of the system. Externally mounted silencers will not be permitted.

7. Acoustical foam shall be provided between all supports and inside doors and sound baffles on air intake and air discharge.

8. Lifting points on the base frame shall be suitable for lifting combined weight on the base tank, generator set, enclosure, and fuel tank. A tested and certified single point lifting facility to aid in generator placement.

C. Prototype Tests and Evaluation: Prototype tests shall have been done on a complete and function unit, component-level type tests will not substitute for this requirement.

D. Performance:

1. Voltage regulation shall be ± 0.5 percent for any constant load between no load and rated load.

2. Frequency regulation shall be isochronous from steady state no load to stated state rated load.

3. The diesel engine-generator set shall be capable of single step load pick up of 100 percent nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.

4. The generator set shall be capable of sustaining a minimum of 90 percent of rated no-load voltage with specified kVA load at near zero power factor applied to the generator set.

5. Maximum transient voltage dip shall not exceed 6 percent and maximum frequency dip shall not exceed 2 percent, below rated, on application of the single largest surge load step.

E. AC Alternator: The AC alternator shall be brushless with brushless exciter, synchronous, four pole, revolving field, drip-proof construction, single prelubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc(s).

1. Insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system. Actual temperature rise measured by resistance method at full load shall not exceed 130 degrees Centigrade.

2. A brushless permanent magnet generator (PMG) shall provide excitation power for immunity from voltage distortion caused by non-linear loads. The PMG shall sustain excitation power for optimum motor starting and to sustain short circuit current at approximately 300 percent of rated current for not more than 10 seconds.

F. The automatic voltage regulator shall be temperature-compensated, solid-state design. The voltage regulator shall be equipped with three-phase RMS sensing. The regulator shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The regulator shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of 58-59 HZ. The torque-matching characteristic shall use differential rate of frequency change compensation to use the maximum available engine torque and provide optimal transient load response. Regulators which use a straight-line fixed volts per hertz characteristic are not acceptable.

G. Engine-Generator Set Control. The generator set shall have a microprocessor-based control system equivalent to the Kohler Decision-Maker 550 Controller. Provide Modbus RTU Ethernet communications.

H. An electronic governor shall provide automatic isochronous frequency regulation adjustable from no load to full load.

I. The engine shall be turbocharged or naturally aspirated as required for the horsepower required to meet the load requirements for a standby rated system.

1. Frame-mounted close-loop radiator system rated for full load operation in 122 degrees F (50 degrees C) ambient as measured at the generator air inlet. Radiators shall be provided with a duct adaptor flange. The cooling system shall be filled with 50/50 ethylene glycol/water mixture by the equipment supplier. Rotating parts shall be guarded against accidental contact in accordance with regulations. The system shall properly cool the engine with up to 0.5" H2O static pressure on the fan.

2. A critical type exhaust silence, companion flanges, and flexible stainless steel exhaust fitting properly sized shall be furnished. The silencer shall be coated for temperature and rust resistance. Gas-proof, seamless, stainless steel, flexible exhaust bellows with threaded NPT connection.

3. An electronic isochronous governor capable of 2% steady-state frequency regulation. Electric solenoid shut-off valve.

4. A 12 or 24 volt positive engagement solenoid shift-starting motor capable of a single 30-second crank period without overheating.

5. A 45-ampere minimum automatic battery charging alternator with solid-state voltage regulation.

6. Oil dipstick.

7. Coolant level indicator and switch.

8. Positive displacement, mechanical, full pressure, lubrication oil pump. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.

9. An engine-driven, mechanical, positive-displacement fuel pump capable of lifting the fuel from the trailer mounted fuel tank.

10. Water separator type fuel filter with replaceable spin-on canister element.

11. Replaceable dry element air cleaner with air restriction indicator.

12. Flexible supply and return fuel lines.

13. Certified by the Environmental Protection Agency (EPA) to conform to the latest Tier requirements for nonroad emissions regulations.

J. Base: The engine-generator set shall be mounted on a heavy duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails. Provide spring vibration isolators between the engine and the steel base to reduce vibration.

K. Main Circuit Breaker: 480 VAC, 3-pole, molded case, thermal-magnetic type, sized per NEC.

L. Generator Set Auxiliary Equipment and Accessories:

1. Starting and Control Batteries: Starting batteries, lead acid-type, 12 or 24 volt DC, sized as required to deliver the manufacturer's recommended cold cranking amps, 770 CCA minimum, required at 0 degrees Fahrenheit, per SAE Standard J-537, shall be supplied with battery cables, connectors, and a battery disconnect switch.

2. Automatic float and equalize battery charger (6-ampere) with 1% constant voltage regulation from no load to full load over 10% AC input line variation, current limited during engine cranking and short circuit conditions, temperature compensated for ambient from -40 centigrade to 70 degree centigrade, 5% accurate voltmeter and ammeter, fused, reverse polarity and transient protected.

3. Provide isolated, Form C type, dry contacts for remote indication of alarms. At a minimum, provide the following alarms:

   a. Emergency Shutdown.
   b. Generator running.
   c. Water High Temp.
   d. Low oil level
   e. Generator fail to start.
   f. Day tank leak detection.
   g. Day tank low fuel level shutdown.
   h. Day tank low fuel level alarm.

   Alarms shall also be routed into inputs on the control panel and shall be available over the Ethernet connection.

4. Block heater rated 120 volts.

5. Skid and isolation vibrators.

6. UL142 listed closed top-diked fuel tank located in the generator steel base. The tank shall be sized for 24 hour operation at full load and shall be provided with a low level alarm, leak detection alarm, critical low fuel level shutdown, and low fuel level alarm. The fuel tank shall be provided with an anti-siphon valve, no spill fill tube, and over flow drain. The fuel level gauge shall be located less than 12" from the fuel fill point. All fuel lines shall be made of flexible Type 1 material. Provide an emergency pressure relief vent cap for both the inner and outer fuel tank. Tank shall meet the requirements of NFPA 30 and NFPA 37.

7. Provide electrical stub up area in subbase tank.

8. Provide epoxy mastic coating.

2.4 TRANSFER SWITCH EQUIPMENT:

A. Provide automatic transfer switch as specified in Section 16491.

PART 3 EXECUTION:

3.1 INSTALLATION:

A. Installation shall comply with NEC and National Fire Code. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.

3.2 FACTORY TESTS:

A. Perform generator set factory tests on the equipment to be shipped at rated load and 0.8 PF. Generator sets that have not factory tested at 0.8 PF shall not be acceptable. Tests shall include: ½ hour run at full load, maximum power, voltage regulation, transient and steady-state governing, single step load pickup, and safety shutdowns. Submit documentation of factory test.

3.3 ON-SITE ACCEPTANCE TEST:

A. The complete installation shall be tested for specification compliance following completion of the work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by Contractor. The Engineer shall be notified in advance and shall have the option to witness the tests. Installation acceptance tests to be conducted on-site shall include a "cold start" test, a two-hour full-load test, and a one-step rated load pickup test in accordance with NFPA 110. Provide a resistive load bank and make temporary connections for full load test, if necessary.

3.4 REFUELING:

A. After completion of all field testing, the Contractor shall furnish and install enough No. 2 diesel fuel, or for cold weather operation provide No. 1 diesel fuel, at time of final acceptance to completely fill the fuel storage tank, at no additional expense to the Owner. If, at the completion of testing, any of the fuel is more than 3 months old, the fuel shall be removed and the tank refilled with fresh fuel. After refueling, provide fuel conditioning or preservative recommended by the manufacturer.

3.5 GROUNDING AND BONDING:

A. The generator unit is not a separately derived system per NEC Article 250.30, and the generator neutral shall not be bonded and grounded at the unit. The equipment grounding conductor shall be bonded to the generator housing and to the ATS ground bar.

END OF SECTION

SECTION 16675

TRANSIENT VOLTAGE SURGE SUPPRESSION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A Section includes field-mounted SPDs for low-voltage (<1000 V) power distribution and control equipment.

1.3 DEFINITIONS

A. VPR: Voltage Protection Rating.

B. SPD: Surge Protective Device(s).

C. $I_{(n)}$: Nominal Discharge Current.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating weights, electrical characteristics, furnished specialties, and accessories.

B. Qualification Data: For qualified testing agency.

C. Product Certificates: For SPDs from manufacturer.

D. Operation and Maintenance Data: For SPDs to include operation, and maintenance manuals.

E. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency, and marked for intended location and application.

B. The unit shall be UL 1449 Listed and CUL Approved as a Surge Protective Device and UL 1283 Listed as an Electromagnetic Interference Filter.

C. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.

D. Comply with NFPA 70.

E. PROJECT CONDITIONS

1. Service Conditions: Rate SPDs for continuous operation under the following conditions unless otherwise indicated:

a. Maximum Continuous Operating Voltage (MCOV) of not less than 115% for 277/480V and 125% for 120/208V nominal RMS operating system voltage.

b. Operating Temperature: 30 to 150 deg F.

c. Humidity: 0 to 95 percent, non-condensing.

d. Altitude: Less than 12,000 feet above sea level.

1.6 COORDINATION

Coordinate location of field-mounted SPDs to allow adequate clearances for maintenance.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fails in materials or workmanship within specified warranty period.

Warranty Period: 10 years from date of Substantial Completion.

1.8 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Replaceable Protection Modules: one of each size and type installed.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Square D.

B. MVC, Inc. (800) 583-4773

C. Approved Equal.

2.2 SERVICE ENTRANCE SUPPRESSORS:

A. Surge Protective Devices shall be:

1. ANSI/UL 1449 Listed.

2. Modular design (with field-replaceable modules).

3. Fuses, rated at 200-kA interrupting capacity.

4. Minimum ANSI/UL 1449-2006 withstand (I_n) rating to be 20kA per mode.

5. Tested with the ANSI/IEEE Category C_{High} exposure waveform (20kV-1.2/50μs, 10kA-8/20μs).

6. Pulse life test: Capable of protecting against and surviving 20,000 ANSI/IEEE Category C_{High} transients without failure or degradation of clamping voltage by more than 10%.

7. Bolted compression lugs for internal wiring.

8. Coordinated thermal and surge current fusing.

9. Redundant suppression circuits.

10. Replaceable modules, 1 per phase minimum.

11. LED indicator lights for power and protection status.

12. Audible alarm, with silencing switch, to indicate when protection has failed.

13. Form-C contacts rated at 2 A and 24-V ac minimum, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.

14. Six-digit transient-event counter set to totalize transient surges.

B. Peak Single-Impulse Surge Current Ratings to be selected by environment:

Category/Type	Application	Per Phase	Per Mode
C Type 2	Service Entrance	240 kA	120 kA
B Type 2	High Exposure Locations (Distribution Equipment)	160 kA	80 kA

C. The ASNI/UL 1449 voltage protection rating (VPR) in grounded wye circuits, the SPDs shall not exceed the following:

Modes	208Y/120	480Y/277	600Y/347
L-N,L-G, N-G	800	1200	1500
L-L	1200	2000	2500

D. The ANSI/UL 1449 VPR for 240/120 V, 3-wire or 4-wire circuits with high leg shall not exceed the following:

Modes	240/120
L-N,L-G, N-G	1200/800

2.3 ENCLOSURES

A. Outdoor Enclosures: NEMA 250 Type 4X.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install SPDs at the service entrance on the load side, with ground lead bonded to service entrance ground.

B. Install SPDs for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

C. Provide a 60 Amp circuit breaker as a dedicated disconnecting means for SPD unless otherwise indicated.

D. The SPDs ground shall be connected to the power system ground.

3.2 FIELD QUALITY CONTROL

A. Ensure that interiors are free of foreign materials and dirt.

B. Check and test switches, pushbuttons, meters for proper operation.

C. Check and test indicating lights for proper operation and color.

D. Perform manufacturer's on site field test procedures.

3.3 STARTUP SERVICE

A. Do not perform insulation resistance (MEGGER) tests of the distribution wiring equipment with the SPDs installed. Disconnect all wires, including neutral, before conducting insulation resistance tests, and reconnect immediately after the testing is over.

B. Test the unit status by pressing the buttons below the Phase LED on the diagnostic panel. The LED will turn from Green to Red while the button is pressed. The LED will return to Green upon release of the Phase button.

END OF SECTION

APPENDIX A

GEOTECHNICAL REPORT

Enprotec / Hibbs & Todd

February 2, 2017

Mr. Russell Pehl, P.E.
Engineering Services Department
72 W. College Avenue
San Angelo, Texas 76903

Re: Geotechnical Investigation
Sulphur Draw Wastewater Improvements
San Angelo, Texas

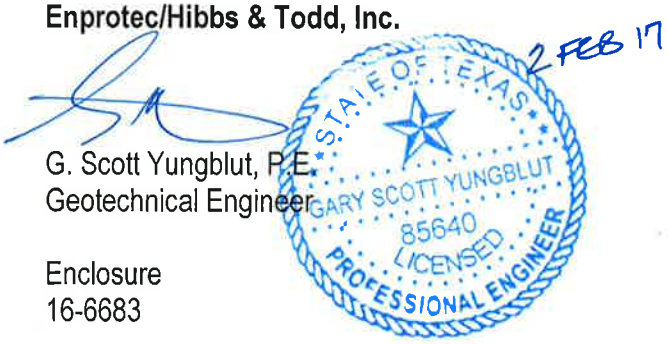
Dear Mr. Pehl:

In accordance with your instructions, we have conducted a Geotechnical Investigation for the above referenced project. The conclusions and recommendations of this investigation are to be found in the attached report.

We trust that this will provide the information you have requested. We are also available for the geotechnical and materials testing services during construction as recommended in the Report. If there are any further questions, please do not hesitate to call.

Sincerely,

Enprotec/Hibbs & Todd, Inc.



G. Scott Yungblut, P.E.
Geotechnical Engineer

Enclosure
16-6683

GEOTECHNICAL INVESTIGATION

SULPHUR DRAW WASTEWATER IMPROVEMENTS
SAN ANGELO, TEXAS

TABLE OF CONTENTS

GEOTECHNICAL INVESTIGATION
FOR THE
SULPHUR DRAW WASTEWATER IMPROVEMENTS
SAN ANGELO, TEXAS

INTRODUCTION

GENERAL: This investigation was authorized through Task Order No. 1 and Purchase Order No. 113420 between the City of San Angelo Engineering Services Department and Enprotec / Hibbs & Todd, Inc. (eHT). The purpose of this investigation is to provide foundation design information along with construction recommendations for the Lift Station in the Sulphur Draw Wastewater Improvements project in San Angelo, Texas.

The project includes the installation of a concrete lift station along with the associated valve vault and plumbing. It is understood that the base of the lift station will extend about 28 feet below existing grade.

SCOPE: The scope of the exploration and analysis to be performed by eHT included a site reconnaissance, the subsurface exploration, field and laboratory testing, and an engineering analysis and evaluation to provide design recommendations for the lift station foundation along with construction recommendations for the proposed project. Details and results of the investigation are discussed in the following sections of this report.

LIMITATIONS: The Geotechnical Engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been made after being prepared in accordance with generally accepted professional engineering practice in the fields of foundation engineering, soil mechanics, and engineering geology. No other warranties are implied or expressed.

SITE DESCRIPTION

SITE LOCATION & TOPOGRAPHY: The proposed lift station site is generally located in the northwest quadrant formed by the intersection of Paseo De Vaca Street and S. Washington Street in San Angelo, Texas. At the time of the subsurface exploration the site was covered with native grasses. There were also some mesquite trees in the area. Site topography sloped from the northwest down to the south-southeast towards the street.

DESCRIPTION OF WORK

FIELD INVESTIGATION: Drilling and soil sampling activities were performed at a select location of the subject site on December 13, 2016. Four test borings were drilled to depths ranging from 15 to 30 feet below the existing ground surface elevation at the locations shown on Figure 1 in the Appendix. Test Boring No. 1 was drilled in the area of the lift station and the other three test borings were drilled along the proposed route of the new sewer line.

The test borings were drilled utilizing a truck-mounted Failing rotary drilling rig. The test borings were advanced utilizing dry sampling methods and/or rotary air drilling techniques which allow for accurate groundwater observations. Drilling and sampling activities were performed in general accordance with referenced ASTM and/or TxDOT procedures or other accepted methods.

Soil formations were sampled using a 3-inch diameter Shelby-type steel tube sampler (ASTM D 1587) and/or a 2-inch split barrel sampler (ASTM D 1586). Undisturbed soil samples were subjected to calibrated pocket penetrometer tests (Qp) to assist in evaluating the shear strength of the cohesive soils. Quantitative estimates of the foundation strata bearing capacity were also obtained from interpretation of the Standard Penetration Test (SPT) results and widely published empirical correlations. The reports of the field tests are reported on the Logs of Borings in the Appendix.

The borings were visually logged in the field, and all recovered samples were placed in core boxes for delivery to the laboratory. Push-tube samples, split spoon samples, and auger grab samples were placed in polyethylene plastic bags to minimize moisture changes. Samples will be retained for 30 days from the date of this report. The samples will then be discarded unless notified in writing by the client requesting the samples be retained.

The borings were observed for groundwater at the test locations, during and following the completion of the borings. These observations are shown on the Logs of Borings and discussed in a later section of this report. The borings were backfilled with on-site materials upon completion of the fieldwork. Logs of Borings were subsequently prepared, along with a legend titled EXPLANATION OF SYMBOLS AND TERMS USED ON BORING LOGS and GENERAL NOTES. The legend and general notes show typical soil and rock classifications, drilling symbols, weathering descriptions, and soil structure characteristics.

LABORATORY TESTING: Select materials recovered in the borings were tested in the laboratory and classified based on the laboratory test results. Laboratory testing was conducted in general accordance with ASTM procedures and standards. Atterberg Limits (ASTM D 4318) and Minus 200-Mesh Sieve Tests (ASTM D 1140) were performed on selected soil samples in order to classify and establish index properties and grain size characteristics of the soils. A summary of the results of the classification tests are included in the Appendix. The soil classifications are based on the Unified Soil Classification System (USCS).

ENGINEERING ANALYSIS: An engineering analysis was conducted on the information obtained from the field investigations and from information provided by Mr. Sage Diller, P.E., Project Manager for eHT. If revisions to the plans for the proposed project, or if deviations from the subsurface conditions presented in this report are encountered during construction, we should be notified to determine if changes in our recommendations are required.

SUBSURFACE MATERIALS AND CONDITIONS

SITE GEOLOGY: As shown on the San Angelo Sheet of the *Geologic Atlas of Texas* the site is located in an area where Quaternary Age Deposits of the Caliche Formation are present at or near the surface. The Caliche Formation in the project forms partially alluviated flats above the level of fluviatile terraces.

SITE STRATIGRAPHY: A detailed description of the site stratigraphy is provided on the Log of Boring. Generally the subsurface conditions at the site may be characterized as follows:

LIFT STATION (B-1): Very stiff to hard comparative consistency sandy clays and clayey silts were present from the surface to a depth of about 11 feet. The clays and silts were underlain by limestones with interbedded silt seams. Highly weathered shale with interbedded limestone seams were encountered beneath the limestones which extended to at least a depth of 30 feet.

SEWER ROUTE (B-2): Stiff to hard comparative consistency sandy clays were present from the surface to a depth of about 11 feet. Highly weathered sandy shales were encountered beneath the clays which extended to at least a depth of 15 feet.

SEWER ROUTE (B-3): Asphaltic pavement with base material was present at the surface. Underlying the pavement was a 6 inch layer of very stiff clay. Limestone with interbedded sand and gravel seams were present beneath the clays to a depth of about 10 feet, where sound limestones were encountered and extended to at least a depth of 30 feet.

SEWER ROUTE (B-4): Very Stiff to hard sandy clays were present from the surface to a depth of about 16½ feet. There was also a 2 foot layer of firm relative density clayey sands at a depth of 6 feet. A 3½ foot layer of sand and gravel was encountered beneath the sandy clays. Highly weathered sands were present beneath the sands and gravel which extended to at least a depth of 20 feet, the termination depth of the test boring due to caving sands and gravel.

GROUNDWATER: Groundwater was encountered at a depth of about 7½ feet at Test Boring No. 2, and about 18 feet at Test Boring Nos. 1 and 4 during and at completion of drilling activities. Groundwater was not encountered within Test Boring No. 3. Groundwater may typically be found within the alluvial soils and particularly in contact with the limestones and shales. An accurate depiction of the groundwater depth would require leaving the test boring open for an extended period of time. Based upon the measured water level and soil moisture contents the groundwater table was considered to exist at a depth of about 18 feet in the lift station area at the time of the subsurface exploration, although shallower perched water may exist in areas of the site. The water table may fluctuate seasonally and during periods of heavy rainfall.

Groundwater may affect excavation and construction of the lift station foundation at this site. Based upon the groundwater encountered it may be necessary to either install a well point system adjacent to the excavated area or place a sump pump in the bottom of the excavation to dewater the area during construction.

LABORATORY RESULTS: The results of the Atterberg Limits Testing indicate that the tested soils possess liquid limits (LL) ranging from 26 to 41 with corresponding Plasticity Indices (PI) of 13 to 24. Soil Classification Tests indicate that the soils exhibit a low to moderate expansive potential with a moderate degree of plasticity. The soils are classified as CL materials according to the Unified Soil Classification System (USCS). Refer to the Appendix for the laboratory test results of the materials tested.

FOUNDATION DESIGN RECOMMENDATIONS

LIFT STATION FOUNDATION DESIGN: A mat foundation will provide support for the lift station and will also provide resistance to any associated uplift forces. A maximum net allowable bearing pressure of 5.0 kips per square foot may be utilized in the highly weathered shale with limestone seams at depths between 25 and 30 feet below existing grade which provides for a safety factor of at least 3 against a shear failure in the supporting soils. The weight of the concrete, overburden of backfill, and friction will provide the total uplift resistance. The following design criteria can be used for the lift station:

Unit weight of concrete:	150 pcf
Unit weight of grout backfill:	130 pcf
Unit weight of soil backfill:	125 pcf

A minimum 8 to 12 inches of ¾ to 1 inch clean gravel should be placed beneath the mat foundation. The gravel should be properly compacted with a vibratory plate to a minimum relative density of 75 percent.

FOUNDATION CONSTRUCTION RECOMMENDATIONS

SITE CLEARING: Initial site preparation will require the removal of the moderately organic topsoil present across the site. Removal depths should be verified in the field by a representative of the geotechnical engineer at the time of site grading based upon the subgrade soils and the subgrade stability.

FOUNDATION EXCAVATION: Excavations should be observed by the geotechnical consultant or his representative to make sure that the proper bearing material has been reached in accordance with the recommendations given herein. The excavations should be checked for size and observed to make sure that all loose material has been removed prior to gravel and concrete placement. Prompt placement of the concrete following gravel and rebar preparation is strongly recommended.

UTILITIES: Prior to construction all underground utilities should be located and, if present in the construction area, permanently capped and removed at the property line or rerouted around the proposed lift station to preserve their function. Special attention should be performed in evaluating the backfill of utilities that will remain which may not be suitable for support of the proposed structure. The soils should be removed and recompacted if found unsuitable. This determination should be made by a representative of the geotechnical engineer during construction.

EXCAVATION BACKFILL: The excavated material may be used as backfill following construction of the lift station. The fill should be compacted to a minimum 90 percent Standard proctor (ASTM D 698) at above optimum moisture content. Compacted lift thicknesses should not exceed 6 inches. Over-compaction of the clayey soils should be avoided to prevent aggravating potentially swelling soil problems such as differential heave of any fill. Consideration may also be given to using a low strength grout for backfill behind the lift station walls.

FOUNDATION CONSTRUCTION CONSIDERATIONS

EXCAVATION SAFETY: All excavations should be in accordance with local and federal (OSHA) regulations and the trench safety plan. If instability problems occur, stability within the excavations should be maintained by flattening or widening slope sidewalls. In addition, the on-site soils are susceptible to erosion and disturbance by flowing water and construction traffic. If these soils are disturbed by construction traffic and excessive moisture they may become unstable. The site should therefore be graded to prevent water from ponding near and running into the excavation.

EXCAVATION DIFFICULTIES: Weathered limestones and shales were encountered in the area of the proposed lift station. It is anticipated that some excavation in the area may require specialized excavation equipment. Furthermore, excavation bank stability problems may also be encountered. In this event, shallow excavations may be sloped or widened in the anticipation of bank stability problems, with deeper excavations possibly requiring more elaborate external support means for stability. All excavations should be performed in accordance with OSHA requirements, which will be the responsibility of the project contractor.

GENERAL: Many problems can be avoided or solved in the field if proper inspection and testing services are provided. A qualified construction materials testing laboratory should be retained to perform testing and inspection services sufficient to verify compliance with our recommendations. It is recommended that the site preparation and foundation construction be monitored by the geotechnical engineer or his representative. The following are recommended minimum sampling and testing frequencies.

CONCRETE: At least 1 slump, air content (if required) and temperature test, and at least 1 set of 3 concrete cylinders should be molded for each type of concrete placed in a day. Each set of cylinders should be tested for compressive strength with 1 of the cylinders tested at 7 days and 2 of the cylinders tested at 28 days.

APPENDIX

NOT TO SCALE

BORING LOCATION PLAN

FIGURE 1

SULPHUR DRAW WASTEWATER IMPROVEMENTS
SAN ANGELO, TEXAS

Project No.: 16-6683

Date: December 2016

SULPHUR DRAW WASTEWATER IMPROVEMENTS
SAN ANGELO, TEXAS
SUMMARY OF CLASSIFICATION TESTS

Boring No.	Depth (ft)	Liquid Limit %	Plasticity Index	% Passing #200 Mesh Sieve	Water Content %	USCS	Description
B-1	2-3½'	35	19	84	18.7	CL	Dark Brown and Tan Sandy Clay with gravel
B-1	5-6'	35	18	98	15.4	CL	Light Tan and Red-Brown Clayey Silt
B-1	6-8½'	36	19	90	12.6	CL	Light Tan and Red-Brown Clayey Silt
B-1	13½-15'	36	20	78	14.7	---	Tan Highly Weathered Limestone with interbedded silt seams
B-1	18½-20'	41	24	88	25.7	---	Tan and Gray Highly Weathered Shale with interbedded limestone seams
B-2	5-7'	31	16	---	7.8	CL	Dark Gray Sandy Clay with gravel
B-2	13½-15'	41	24	79	20.7	---	Tan and Gray Highly Weathered Sandy Shale
B-4	2-3½'	30	15	52	9.7	CL	Brown Sandy Clay
B-4	8½-10'	26	13	52	12.4	CL	Brown Sandy Clay
B-4	13½-15'	35	18	53	17.7	CL	Brown Sandy Clay

ENPROTEC/HIBBS & TODD, INC.
ENVIRONMENTAL AND CIVIL ENGINEERING
402 Cedar Street
Abilene, Texas 79601
(325) 698-5560
Firm Registration No. 1151

LOG OF BORING

Project: **SULPHUR DRAW WW IMPROVEMENTS**

Date: 12/13/2017

Location: **SAN ANGELO, TEXAS**

Type: AIR ROTARY

Boring No.: **B-1**

DEPTH IN FEET	SYMBOL	SAMPLE	MATERIAL DESCRIPTION	N-BLOWS PER FOOT	TEXAS CONE PENETROMETER 1st 6"	TEXAS CONE PENETROMETER 2nd 6"	Qp (tsf)	DEPTH SCALE
		ST	DARK BROWN SANDY CLAY				2.5	
		ST	DARK BROWN AND TAN SANDY CLAY WITH GRAVEL				4.5+	
		SS	LIGHT TAN AND RED-BROWN CLAYEY SILT	26				
5		ST					4.5+	
		AU						
		SS	TAN HIGHLY WEATHERED LIMESTONE WITH INTERBEDDED SILT SEAMS	50/5"				
10								
		SS		50/4"				
15								
		SS	TAN AND GRAY HIGHLY WEATHERED SHALE WITH INTERBEDDED LIMESTONE SEAMS	85/9"				
20								
		SS		50/1"				
25								
		SS		50/4"				
30			TOTAL DEPTH OF BORING 30 FEET					

NOTE

GROUNDWATER PRESENT AT A DEPTH OF ABOUT 18' DURING AND AT COMPLETION OF DRILLING ACTIVITIES.

16-6683

ENPROTEC/HIBBS & TODD, INC.
ENVIRONMENTAL AND CIVIL ENGINEERING
402 Cedar Street
(325) 698-5560
Abilene, Texas 79601
Firm Registration No. 1151

LOG OF BORING

Project: **SULPHUR DRAW WW IMPROVEMENTS**

Date: 12/13/2017

Location: **SAN ANGELO, TEXAS**

Type: AIR ROTARY

Boring No.: **B-2**

DEPTH IN FEET	SYMBOL	SAMPLE	MATERIAL DESCRIPTION	N-BLOWS PER FOOT	TEXAS CONE PENETROMETER 1st 6"	TEXAS CONE PENETROMETER 2nd 6"	Qp (tsf)	DEPTH SCALE
		ST	DARK BROWN SANDY CLAY				4.5+	
		ST					1.5	
		SS	BROWN AND GRAY SANDY CLAY WITH FINE GRAVEL	17				
5		ST	DARK GRAY SANDY CLAY WITH GRAVEL				1.5	
		ST					1.5	
		SS	TAN AND GRAY SANDY CLAY WITH GRAVEL	17				
10								
			TAN AND GRAY HIGHLY WEATHERED SANDY SHALE					
		SS		63				
15								

TOTAL DEPTH OF BORING 15 FEET

NOTE

GROUNDWATER PRESENT AT A DEPTH OF ABOUT 7½'
DURING AND AT COMPLETION OF DRILLING ACTIVITIES.

16-6683

ENPROTEC/HIBBS & TODD, INC.
ENVIRONMENTAL AND CIVIL ENGINEERING
402 Cedar Street
(325) 698-5560
Abilene, Texas 79601
Firm Registration No. 1151

LOG OF BORING

Project: **SULPHUR DRAW WW IMPROVEMENTS**

Date: 12/13/2017

Location: **SAN ANGELO, TEXAS**

Type: AIR ROTARY

Boring No.: **B-3**

DEPTH IN FEET	SYMBOL	SAMPLE	MATERIAL DESCRIPTION	N-BLOWS PER FOOT	TEXAS CONE PENETROMETER 1st 6"	TEXAS CONE PENETROMETER 2nd 6"	Qp (tsf)	DEPTH SCALE
			2" ASPHALT WITH 6" CRUSHED LIMESTONE BASE					
		ST	DARK BROWN SANDY CLAY WITH LIMESTONE FRAGMENTS				4.0	
		AU						
		SS		50/1"				
5			TAN LIMESTONE WITH INTERBEDDED SAND AND GRAVEL					
		SS		50/0"				
10								
		SS		50/0"				
15								
		SS		50/0"				
20			TAN LIMESTONE					
		SS		50/0"				
25								
		SS		50/0"				
30			TOTAL DEPTH OF BORING 30 FEET					

NOTE

NO GROUNDWATER WAS PRESENT DURING OR AT COMPLETION OF DRILLING ACTIVITIES.

16-6683

ENPROTEC/HIBBS & TODD, INC.
ENVIRONMENTAL AND CIVIL ENGINEERING
402 Cedar Street
(325) 698-5560
Abilene, Texas 79601
Firm Registration No. 1151

LOG OF BORING

Project: **SULPHUR DRAW WW IMPROVEMENTS**

Date: 12/13/2017

Location: **SAN ANGELO, TEXAS**

Type: AIR ROTARY

Boring No.: **B-4**

DEPTH IN FEET	SYMBOL	SAMPLE	MATERIAL DESCRIPTION	N-BLOWS PER FOOT	TEXAS CONE PENETROMETER 1st 6"	TEXAS CONE PENETROMETER 2nd 6"	Qp (tsf)	DEPTH SCALE
		ST	BROWN SANDY CLAY				4.0	
		ST					4.5+	
		SS		10				
5		ST					4.5+	
			BROWN CLAYEY SAND					
		ST					4.0	
		SS		10				
10			BROWN SANDY CLAY					
		SS		13				
15			TAN SANDS WITH SMALL TO MEDIUM GRAVEL					
		SS	RED-BROWN HIGHLY WEATHERED SHALE	80/10"				
20								

TOTAL DEPTH OF BORING 20 FEET
DUE TO CAVING SANDS AND GRAVEL

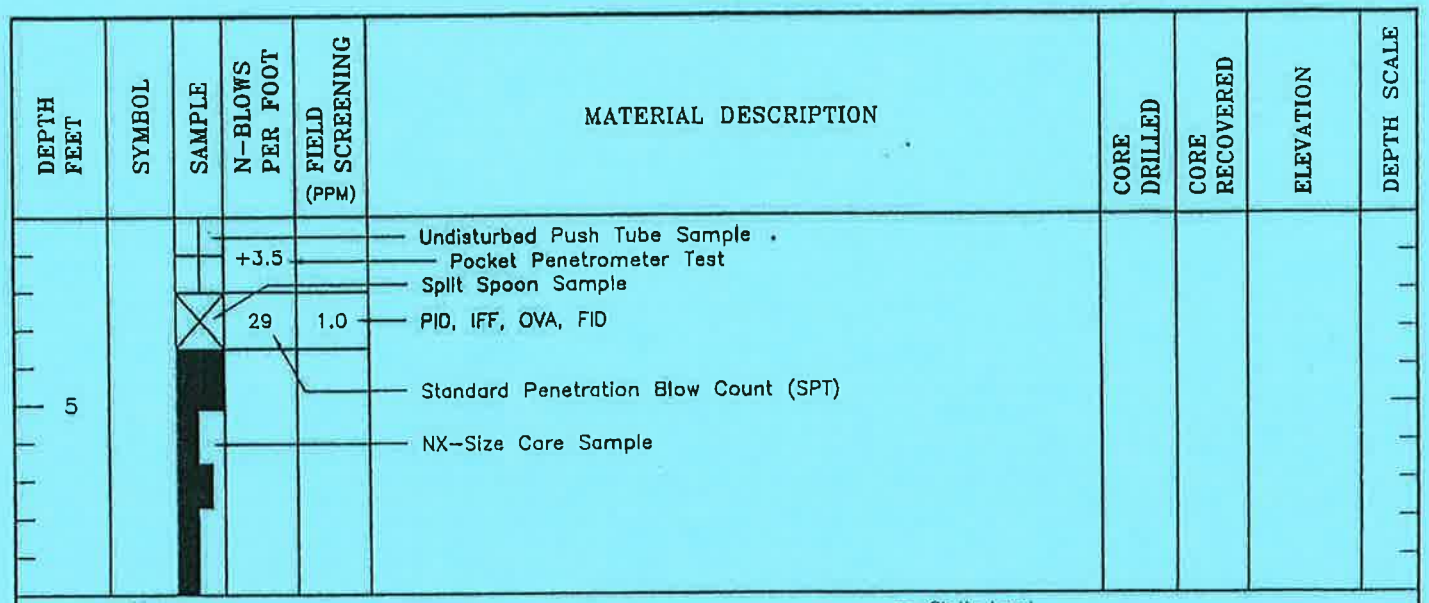
NOTE

GROUNDWATER PRESENT AT A DEPTH OF ABOUT 18' DURING AND AT COMPLETION OF DRILLING ACTIVITIES.

16-6683

ENPROTEC, INC.

EXPLANATION OF SYMBOLS AND TERMS USED ON BORING LOGS



Water Encountered — Water Level Encountered During Drilling

Static Level (date) — Stabilized Water Level

UNIFIED SOIL CLASSIFICATION DESCRIPTION OF SYMBOLS AND DIVISIONS

- Well-Graded Gravels, Gravel Sand Mixtures (GW)
- Poorly-Graded Gravels, Gravel Sand Mixtures (GP)
- Silty Gravel, Gravel Sand-Silt Mixtures (GM)
- Clayey Gravels, Gravel-Sand-Clay Mixtures (GC)
- Well-Graded Sands, Gravelly Sands (SW)
- Poorly-Graded Sands, Gravelly Sands (SP)
- Silty Sands, Poorly-Graded, Sand-Silt Mixtures (SM)
- Clayey Sands, Poorly-Graded, Sand-Clay Mixtures (SC)
- Inorganic Silts and Very Fine Sands, Silty or Clayey Fine Sands (ML)
- Inorganic Clays of Low to Medium Plasticity Gravelly, Sandy or Silty Clays, Lean Clays (CL)
- Organic Silts and Organic Silty Clays of Low Plasticity (OL)
- Inorganic Silts, Micaceous or Diatomaceous Fine Sandy or Silty Soils (MH)
- Inorganic Clays of High Plasticity, Fat Clays (CH)
- Organic Clays of Medium to High Plasticity, Organic Silts (OH)
- Caliche and Other Impervious Layer (HP)

BEDROCK SYMBOLS

- Conglomerate (CGL)
- Sandstone (SS)
- Limestone (LS)
- Shale (Sh)
- Weathered Shale (WS)
- Sandy Shale (SSh)
- Shaley Limestone (Sh LS)
- Dolomite (DOL)

MISCELLANEOUS SYMBOLS

- Asphaltic Concrete (HMAC)
- Cement Grout (CMT)
- Bentonite (BENT)

The LOG of BORING is a representation of the subsurface material at specific boring location and within the depth explored. The transition between strata may be gradual and variations in material types and depths between borings can be expected. Water level observations represent those conditions at the time of exploration and may vary with time and location of site.

SOIL COLOR CLASSIFICATION
Determined by
MUNSELL SOIL COLOR CHARTS
1990 EDITION REVISED

GENERAL NOTES

SAMPLE IDENTIFICATION

Soil Samples are visually classified in general accordance with the Unified Soil Classification System (ASTM D2487 or D 2488)

DRILLING AND SAMPLING SYMBOLS

ST:	Shelby Tube - 3" O.D., except where noted
SS:	Split-Spoon
THD:	THD Cone Penetrometer
AU:	Auger Sample
DB:	Diamond Bit
CB:	Carbide Bit
WS:	Wash Sample

SOIL PROPERTY SYMBOLS

N:	Standard "N" penetration: Blows per foot, or fraction thereof, of a 140 pound hammer 30 inches on a split-spoon
Qp:	Calibrated Penetrometer Resistence, TSF
Qu:	Unconfined Compression Strength, TSF
LL:	Liquid Limit, %
PI:	Plasticity Index

SOIL STRENGTH CHARACTERISTICS

NON-COHESIVE (GRANULAR) SOILS

RELATIVE DENSITY	BLOWS PER FOOT(N)
Very Loose	0-4
Loose	5-10
Firm	11-30
Dense	31-50
Very Dense	51 +

COHESIVE (CLAYEY) SOILS

COMPARATIVE CONSISTENCY	BLOWS PER FOOT(N)	UNCONFINED COMPRESSIVE STRENGTH (Qu)
Very Soft	0-2	0 - 0.25
Soft	3-4	0.25 - 0.50
Medium Stiff	5-8	0.50 - 1.00
Stiff	9-15	1.00 - 2.00
Very Stiff	16-30	2.00 - 4.00
Hard	31 +	4.00 +

SOIL CHARACTERISTICS

PARTICLE SIZE

Boulders	8 in. +	Coarse Sand	5mm-0.6 mm	Silt	0.074mm-.005mm
Cobbles	8 in.-3 in.	Medium Sand	0.6mm-0.2mm	Clay	-0.005mm
Gravel	3 in.-5mm	Fine Sand	0.2mm-0.074 mm		

DEGREE OF EXPANSIVE POTENTIAL	PI
Low	0-15
Moderate	15-25
High	25 +

DEGREE OF PLASTICITY	PI
None to Slight	0-4
Slight	5-10
Moderate	11-30
High	31 +

APPENDIX B

AQUATIC RESOURCE PROTECTION PLAN

AQUATIC RESOURCE RELOCATION PLAN

FOR

Sulphur Draw Wastewater Improvements Project
City of San Angelo
Tom Green County, Texas

August, 2017

The City Of
San Angelo, Texas
Engineering Services Department
72 W College Avenue, San Angelo, TX 76903

PREPARED BY:

Enprotec / Hibbs & Todd
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TABLE OF CONTENTS

1.0 Introduction

1.1 Purpose

The City of San Angelo (Owner) contracted Enprotec / Hibbs &Todd, Inc. (eHT or Engineer) to draft an Aquatic Resource Relocation Plan (ARRP) for the proposed Sulphur Draw Wastewater Improvements Project (Project) in San Angelo, Texas. The Project location is generally between West Beauregard Avenue (US Hwy 67 Bus) and South Abe Street (US Hwy 87), near the North Concho River (See attached maps). This ARRP will address ecology, survey methodology, and handling of threatened mussel species and freshwater fish species potentially utilizing the North Concho River crossing. This ARRP also describes Best Management Practices (BMPs) to reduce sediment erosion impact to habitat health of the North Concho River and to prevent or minimize the risk of accidentally possessing or transferring controlled exotic species or pathogens.

1.2 Project Description

The Project is slated to start on 1 October 2017. The Project is located primarily in an urbanized setting and is intended to enhance wastewater utility function in the area of Paseo De Vaca Street. Replacement of the existing gravity sewer line along Paseo De Vaca Street would include the implementation of a new, replacement 18" sewer line to the proposed lift station near the intersection of Paseo De Vaca Street and S. Washington Street. From the proposed new lift station, a new wastewater force main would be installed along S. Washington Street and Live Oak Street towards the North Concho River. The wastewater force main will be a 10" force main pipe that will be laid on or trenched through the bottom of the North Concho River floor and continue eastward through Santa Fe Park. From a new replacement manhole at the park, an upsized replacement 30" gravity sewer pipe will be installed to an existing manhole at the Abe Street Ramp.

Environmental needs will be dependent upon method of pipe installation. Based on the options lined out in the Threatened and Endangered Habitat Assessment (TEHA) report previously developed and on guidance from the Owner, the pipe will be installed using one of two different methods: laying the pipe on the river bed (Option 1), or trenching using isolated coffer dams for dewatering (Option 2).

1.3 Ecological Setting

The project is located within the Central Great Plains ecoregion of Texas. The ecoregion contains a shallow holding of mixed grasslands with mature mesquite groves that are prevalent throughout the once grass filled plains. The ecoregion contains converted farmlands that produce cotton, wheat, and grain sorghum. The area is dissected by shallow canyons, or "breaks", with intermittent open plains for livestock foraging. A previous site visit by the eHT biologist showed predominate vegetation in the project area to include Pecan (*Carya illinoinensis*), Hackberry (*Celtis occidentalis*), Ashe juniper (*Juniperus ashei*), Buffalo grass (*Bouteloua dactyloides*), Bermuda grass (*Cynodon dactylon*), and Crab grass (*Digitaria spp.*).

The North Concho River runs southeast for approximately ninety-eight miles through four Texas counties before connecting with the South and Middle Concho rivers to form the Concho River approximately 1.78 miles east of the proposed Project crossing. According

to the Texas State Historical Association, the North Concho River lies in a natural geologic floodplain comprised of sand, gravel, and mud substrate with some bedrock areas. Clay and sandy loams soil types along the river support a variety of vegetation types.

2.0 Consultation and Communication

Table 1 shows previous consultation between eHT and state / federal agencies.

Table 1: Consultation and Communication History

Date	Agency	Consultation
4/21/2017	eHT	Letter from eHT to Texas Parks and Wildlife Department (TPWD) reviewers concerning project description of Sulphur Draw Wastewater Collection System Improvements Project.
6/1/2017	TPWD	TPWD Reviewers sent response to eHT with recommendations and BMP suggestions concerning wildlife along project.

Communication and clarification of responsibilities are integral to the success of the threatened freshwater mussel mitigation efforts and relocation of freshwater fish species at the Project site. The Owner is responsible to hire a construction contractor (Contractor) to implement all aspects of this ARRP. The Contractor is responsible to implement all work associated with this ARRP, as described herein, at Contractor's expense. The Contractor shall hire a qualified biologist (Biologist) as defined in Section 4.0. Table 2 below provides a summary of the responsibilities of key personnel at the Project concerning threatened freshwater mussels and activities related to aquatic species as described herein.

Table 2: Key Personnel Responsibilities

Role	Responsibility
Contractor	The Contractor is responsible for contacting the Biologist prior to conducting work in or at the North Concho River crossing. Note that a presence/absence survey of freshwater mussels and freshwater fish must be conducted prior to initiating construction. See Section 4.0 for the recommended time frame / conditions.
	The Contractor shall not proceed with work in or at the North Concho River crossing without the approval of the Biologist and the TPWD.
	The Contractor shall manage the activities, recommendations, and requirements set forth in this plan and by the Biologist.
	The Contractor is responsible for ensuring the BMPs and requirements set forth in this ARRP are executed.
Biologist Point of Contact	The Biologist will be responsible for pre-construction presence/absence survey of freshwater mussels and freshwater fish, relocation activities for all aquatic life, and monitoring and evaluating the activities in the North Concho River.
	The Biologist will work closely with the Owner and Contractor on determining the presence/absence of freshwater mussels and fish and implementation of mitigation efforts as determined necessary by the survey.
	The Biologist will notify and coordinate with TPWD, as required, and will submit results of the mussel and fish surveys and relocation to the TPWD.

The Biologist retained by the Contractor shall determine whether or not freshwater fish and threatened freshwater mussel mitigation efforts will be required and if work can proceed. A final decision on proceeding will be communicated from the Biologist to the Contractor. The Contractor notify the Owner, and Engineer of the status.

3.0 Freshwater Mussel Ecology

The Threatened and Endangered Species Habitat Assessment (TEHA) provided by eHT recommended freshwater mussel presence/absence surveys to be performed prior to construction activities. Survey methodology will follow protocols as outlined by Texas Parks and Wildlife (TPWD) in Section 4.0. The three freshwater mussels that are species of concern that could occur at the project crossing at the North Concho River are the Texas Fatmucket (*Lampsilis bracteata*), Texas Fawnsfoot (*Truncilla macrodon*), and the Texas Pimpleback (*Quadrula petrina*). Each of these species is federally listed as a Candidate Species and state listed as Threatened.

3.1 Texas Fatmucket

Physical description
The US Fish and Wildlife Service (USFWS) describes the Texas Fatmucket as a large, elongated mussel that reaches a maximum length of 100 millimeters (mm). The shell is oval to elliptical shaped and tan to greenish-yellow with numerous irregular, wavy, and broad and narrow dark brown rays, with broad rays widening noticeably as they approach the ventral (underside) margin. The nacre (inside of the shell) is white with occasional yellow or salmon coloration and iridescent posteriorly. Females have mantle flaps that often resemble minnows used for dispersing glochidia. Males and females are sexually dimorphic.

Distribution and Habitat
Populations have been historically documented in at least 18 rivers in the upper Colorado, Guadalupe, and San Antonio River systems in the Texas Hill Country and east-central Edwards Plateau region. The Texas Fatmucket was found in many tributaries of the Colorado River, including the Pedernales, Llano, San Saba, and Concho Rivers. Now, Texas Fatmucket populations are known in only nine streams in the Colorado and Guadalupe River systems in very limited numbers. The Texas Fatmucket is considered extirpated from the mainstem of the Colorado River. Sparse populations are known in Colorado River tributaries, including Spring Creek (tributary of Middle Concho River), Llano River, Pedernales River, Onion Creek, Jim Ned Creek, Elm Creek, and the San Saba River. Two live individuals were recorded in 1997 in Spring Creek, but no evidence of this population was found in 2008, due to suspected population elimination from a dry spell in 1999 and 2000 which dried out Spring Creek. The Texas Fatmucket is considered extirpated from the South Concho River; shell fragments were found in gravel bars in Tom Green County in 1997, but no other evidence of the species since has been reported.

This species occurs in moderately sized rivers in mud, sand, or gravel, or mixtures of these and sometimes in narrow crevices between bedrock slabs. Live individuals have been found in relatively shallow water, rarely more than 1.5 meters (m) deep, usually less. Remaining populations typically occur at sites where one or both banks are relatively low,

allowing floodwaters to spread out over land and thereby reducing damage from scouring. Surveys in 2012 and 2013 conducted by the USFWS, US Geological Surveys, and TPWD suggest that the Texas Fatmucket typically occurs in quiet, slow moving waters in fine silt substrate along the perimeter of impounded waters and in rivers near macrophyte growths of which the majority of the water body is made up of bedrock with pool habitat.

There is no specific information on age and size of maturity of the Texas Fatmucket, though the USFWS assumes it is similar to the related Louisiana Fatmucket, which reaches sexual maturity around 36 mm. Texas Fatmucket females have been found gravid (glochidia in the gill pouch) from July through October, although it is estimated that brooding may continue throughout much of the year. Females display a mantle lure to attract host fish, releasing glochidia when the lure is bitten or struck by the fish. Adults are filter-feeders, siphoning algae, bacteria, detritus, microscopic animals, and dissolved organic matter. Juvenile mussels feed using cilia, or fine hairs, on the foot to capture suspended as well as depositional material.

Population Status

It is currently federally listed as a Candidate species and is state listed as Threatened with the State of Texas. The decline of mussels in Texas is believed to be primarily the result of habitat loss and degradation through impoundments, sedimentation, dewatering, sand and gravel mining, and chemical contaminants. Texas Fatmucket populations have declined significantly rangewide and is considered extirpated from most of the Guadalupe River system and hundreds of miles of the Colorado River, as well as from numerous tributaries. Most existing populations are only represented by one or two individuals and are likely not stable or recruiting.

3.2 Texas Fawnsfoot

Physical Description

USFWS description of the Texas Fawnsfoot is a small, relatively thin-shell freshwater mussel that can reach 60 mm (2.4 in) in length but is usually much smaller. The shell is long and oval shaped with an external coloration that varies from yellow, orangish-tan, brown, reddish-brown, and gray-green. The external shell has a pattern of broken rays, chevrons, or irregular blotches. The internal part of the shell is bluish-white and iridescent posteriorly. Males and females are sexually dimorphic.

Distribution and Habitat

The Texas Fawnsfoot is historically known to occur in the Colorado, Trinity, and Brazos River drainages in Central Texas and possibly in parts of Oklahoma. Historical records suggest the Texas Fawnsfoot inhabited much of the Colorado River as far upstream as the North Fork Concho River in Sterling County (northwest of the Project). Only a few individuals have been found alive in the last couple of decades until 2008 when the first live population of Texas Fawnsfoot was discovered in the Brazos River. In 2009, a second population was found in the Colorado River, although very few individuals have been found in recent years thought to be due to drought. According to the USFWS, historical records exist in the North Concho, Concho, and Llano Rivers but recent surveys indicate the extirpation of the species in these areas.

Little information is available about this species' habitat requirements; however, it appears the Texas Fawnsfoot prefers rivers and larger streams. No living individual have been found or documented in lakes, ponds, or reservoirs, suggesting an intolerance of impoundment or deep, low flowing waters created by artificial impoundments. Texas Fawnsfoot prefer sand, gravel, and sandy-mud bottoms in moderately flowing water. According to the Texas Fawnsfoot's USFWS species profile there is no specific information on age, size of maturity, or host fish use for Texas Fawnsfoot. Adult freshwater mussels are filter-feeders, and will siphon algae, bacteria, detritus (waste or debris of any kind), microscopic animals, and dissolved organic matter. Juvenile mussels will use fine hairs to capture algae and detritus.

Population Status

The Texas Fawnsfoot is federally listed as a Candidate Species and is state listed as Threatened. Based off of historical and current data, the Texas Fawnsfoot population has declined range-wide and there are only seven known populations today. According to USFWS, it is believed that this species has been extirpated from nearly all of the Colorado River Basin and from much of the Brazos River Basin. Only the populations in the lower Colorado, San Saba, and Brazos River are believed to be stable with the remaining populations restricted to short stream reaches. It is believed that the decline of mussels in Texas is due to habitat loss and degradation, effects of impoundments, sedimentation, dewatering, sand and gravel mining, and chemical contaminants.

The Texas Fawnsfoot is unlikely to occur in the project area as live individuals have not been documented in the North Concho River in recent years and is believed to be extirpated from this area. Also, the project area is approximately 2 miles upstream of a reservoir which could impact water flow and make the project area possibly intolerable for Texas Fawnsfoot.

3.3 Texas Pimpleback

Physical Description

According to USFWS, the Texas Pimpleback is a large Pimpleback species that is generally 60-90 mm (2.4-3.5 in). The shell of the Texas Pimpleback is generally smooth and moderately thick. The external shell coloration varies from yellowish-tan to dark brown or dark green rays. Internally the shell is white and iridescent. Males and females are sexually dimorphic.

Distribution and Habitat

Historically the Texas Pimpleback existed in Tom Green County in the North Concho River. This species is endemic to Texas and occurs in the Guadalupe and Colorado River systems. It is currently thought to exist in the Concho River, a tributary of the Colorado River. Currently, the Texas Pimpleback's range has significantly declined range-wide and is thought to exist in only five known streams: the lower Colorado River, San Saba River, Concho River, Guadalupe River, and San Marcos River. Only two of these populations are stable and not disjunct, small, and isolated. It has been estimated by USFWS that the Texas Pimpleback has been extirpated from the remainder of its historical range including the North Concho River.

Texas Pimpleback prefer mud, gravel and sand substrates and generally resides in medium to large river with low water flow. Occasionally, this species will occur in gravel-filled cracks in bedrock slab bottoms. Historically this species has not been found in water over 2 m deep or in reservoirs indicating an intolerance of deep, low flowing water created by artificial impoundments. Little information is known on age, or size maturity of the Texas Pimpleback, but it has been recently found that they will use the channel catfish as a host fish. Adult freshwater mussels are filter-feeders, and will siphon algae, bacteria, detritus (waste or debris of any kind), microscopic animals, and dissolved organic matter. Juvenile mussels will use fine hairs to capture algae and detritus. Females with eggs inside have been documented from June through August.

Population Status

The Texas Pimpleback is federally listed as a Candidate Species and is state listed as Threatened. According to USFWS, based off of historical and current data the Texas Pimpleback has been extirpated from most of its former range in hundreds of miles of the Colorado and Guadalupe River systems. There are only two known stable populations with little evidence of recruitment in the Concho River population. The San Saba River population is thought to be the only remaining recruiting population of Texas Pimpleback. The decline of mussels is primarily the result of habitat loss and degradation, with a large contributing factor by the large-scale impoundment of rivers. Known populations of Texas Pimpleback historically have been impacted and declined due to drought.

It is unlikely that the Texas Pimpleback will occur in the project area as it is currently believed to be extirpated from the North Concho River. Also, the project area is approximately 2 miles upstream of a reservoir which could impact water flow and make the project area possibly intolerable for Texas Pimpleback.

4.0 Freshwater Mussel Survey and Monitoring

The three freshwater mussels previously mentioned that could possibly occur in the project area. Freshwater Mussel Survey and Relocation Protocols have been put into place by the Kills and Spills team of TPWD to help minimize impact to freshwater mussels, regardless of listing-status, by construction and maintenance type projects. The Project will cross at the North Concho River where the three mussels have historically existed. Initial freshwater mussel surveys and possible relocation procedures will need to be performed by a qualified biologist before construction activities commence. It is important to note the protocol addresses proper handling techniques as aquatic species can experience many stress factors which can lower rate of survival during relocation activities.

Desired qualifications for personnel conducting the surveys consist of thorough knowledge of the river basin, knowledge of species-specific biological and ecological requirements, and the ability to identify mussel species from the basin, particularly state and federally listed species. Surveys should be conducted between April-November or when water temperatures are greater than or equal to 60° F. A survey conducted outside of this time frame requires prior authorization from TPWD. To minimize stress on mussels, live mussels should be handled gently and placed back to the original location they were found unless it is necessary to relocate them. Place native mussels partially into sediment with the posterior side facing upwards above the sediment, if unsure of

posterior side, lay on substrate surface. The survey area includes the entire project footprint, as well as buffers for areas of potential impact that include a minimum of 50 m upstream of the project footprint, and a minimum of 100 m downstream of the project footprint.

Below are the TPWD Freshwater Mussel Survey and Relocation Protocols which are broken down into two protocols, wadeable waters versus non-wadeable waters. An initial survey will take place to identify what mussel species are in the survey area. If a state-listed mussel is identified then a quantitative survey will need to take place. Estimated time expected to complete the collection and relocation activities is dependent on construction method and survey acreage for pipe installation.

4.1 TPWD Freshwater Mussel Survey and Relocation Protocols:

- Wadeable Waters
    - Initial Survey
        - An initial survey must occur before construction activities commence during which sampling is used to establish the presence/absence of state-listed mussel species. This allows the surveyor to develop a species list of mussels present within the survey area using timed searches with a minimum search time of five hours (divided into five one-hour searches).
        - At the end of each search period (one hour), mussels should be identified and retained in mesh bags submerged in the stream. If no new species of mussels are collected during the fifth search period, the survey is complete. If at least one new mussel species is collected in the fifth search period, additional one-hour search periods are required until no new species are collected.
        - *If at any time during the timed search periods a live state-listed mussel species is encountered, terminate the initial survey process and begin the quantitative survey.
        - Visual, combined with tactile searching (hand grubbing into the top 1-4 inches of substrate), should be used.
        - Select a shoreline and begin searching from downstream to upstream moving back and forth across the stream.
        - *For areas in delineated search area that are non-wadable, SCUBA or surface supplied air equipment should be utilized.
        - Surveyors need to explore all habitat types within the search area including riffles, banks, pools, and backwater areas to locate species that prefer these habitats. Also search areas that include cervices in bedrock, root-wads, undercut banks, and woody-debris.

- All live mussels collected during the timed searches shall be identified, enumerated, and one color photograph should be taken of each live mussel species and of the total mussels collected.

- Mussels should be handled gently during identification.

- Quantitative Survey

  - A Quantitative Survey is needed when state-listed mussel species are located during the Initial Survey within the delineated search area and need to be removed from the delineated survey area to minimize take of these species due to construction and maintenance type projects.

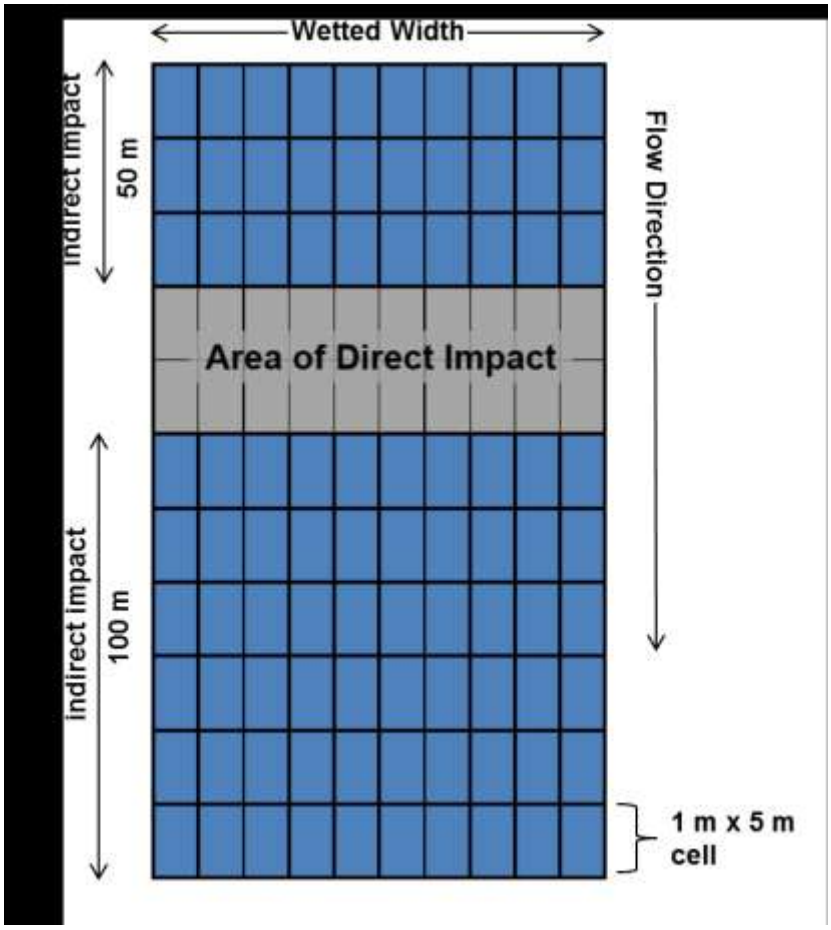
  - A multiple-pass depletion survey method is required within the survey area to ensure that the majority of state-listed mussel species present (and all other subsequently collected mussel species) at the site are removed for relocation.

  - The search area will be divided into 1 m X 5 m cells and each cell will be searched for a minimum of two 10-minute search periods with all live mussels collected in each search period identified and enumerated separately (Figure 1).

  - At the end of the second 10-minute search period if the catch rate (number of individual mussels) is less than 20% of the first 10-minute search period, then that cell is complete and the surveyors may move on to the next cell. If the catch rate during the second 10-minute search period is greater than 20% of the first 10-minute search period then additional 10-minute search periods are required until the catch rate is less than 20% of the first search period for that cell.

  - All live mussels collected during the multiple-pass depletion surveys shall be identified, enumerated, and one color photograph should be taken of each live mussel species and of the total mussels collected.

Figure 1: Example of cell layout for multiple-pass depletion type comprehensive surveys for wadeable locations



- Non-Wadeable Waters
    - Initial Survey
        - An initial survey occurs before construction activities commence during which sampling is used to establish the presence/absence of state-listed mussel species.
        - Only perform survey with snorkel equipment in water no deeper than 3 feet, if greater than 3 feet, SCUBA or surface supplied air (i.e. hookah) equipment may be required to perform survey.
        - In order to ensure entire survey area is covered, transects will need to be oriented parallel with flow and placed on both sides of the bank of the survey area. Transects should be spaced no greater than 5 m apart.
            - Each transect is then divided into 10 m segments, where a minimum of 10 minutes of search time is conducted for each segment using tactile

searches along the transect and a meter on both sides of the transect centerline until all segments of each transect have been surveyed.

- All mussels found will need to be identified, enumerated, and placed in mesh bags submerged in flowing water.

- The area with the highest mussel abundances will need to be resurveyed for an additional one hour. If no additional species are collected, the survey is complete.

- Quantitative Survey

  - A Quantitative Survey is needed when state-listed mussel species are located during the Initial Survey within the delineated search area and need to be removed from the delineated survey area to minimize take of these species due to construction and maintenance type projects.

  - A multiple-pass depletion survey method is required within the survey area to ensure that the majority of state-listed mussel species present (and all other subsequently collected mussel species) at the site are removed for relocation.

  - Additional transects will be placed to make 2.5 m segments.

  - Each segment will be searched for a minimum of two 20-minute search periods with all live mussels collected in each search period identified and enumerated separately.

  - At the end of the second 20-minute search period, if the catch rate (number of individual mussels) is less than 20% of the first 20-minute search period, then that cell is complete and the survey may move on to the next cell. If the catch rate during the second 20-minute search period is greater than 20% of the first 20-minute search period, then additional 20-minute search periods are required until the catch rate is less than 20% of the first search period for that cell.

  - All live mussels should remain in mesh bags submerged in flowing water while not being processed.

  - All live mussels collected during the multiple-pass depletion surveys shall be identified, enumerated, and one color photograph should be taken of each live mussel species and of the total mussels collected.

- Mussel Relocation Protocols

  - *Prior to any mussel relocation activity, it will be necessary to have an approved ARRP, along with a stocking/relocation permit.

- All state-listed mussels should be tagged to aid in the recovery of relocated individuals during post-relocation monitoring.

- Relocation should be located well outside of the project's area of direct and indirect impact (preferably upstream) and near the survey site.

- Mussel relocation sites should be of similar or better quality to that of the survey area and should be of comparable depths and velocities from which the mussels were initially collected preferably to a site of an already established population of the same species.

- Mussels should be transported in an ice chest with a layer of ice to keep them cool and moist. Mussels should be wrapped in a wet towel and a piece of cardboard or similar material should be placed over the ice to protect the mussels from coming in direct contact with the ice and meltwater.

- At the relocation site, the mussels should be carefully placed partially into the sediment with the posterior side facing upwards above the sediment. If uncertain which is the posterior side, the mussels should be laid on the substrate surface.

- Post-relocation surveys should be conducted around one month post-relocation to assess short-term survival of relocated individuals.

    - If observed mortality rates are greater than 10%, TPWD shall be notified and an alternative relocation site shall be discussed.

- A one year post-relocation survey should also be conducted to assess long-term survival of relocated individuals.

    - If observed mortality rates are great than 20%, TPWD shall be notified and an alternative relocation site shall be discussed.

5.0 Freshwater Fish Species

The TPWD lists the following species as Species of Greatest Conservation Need in Tom Green County:

- **Guadalupe Bass (*Micropterus treculii*)**: endemic to perennial streams of the Edward's Plateau region. Spawning period is March through June.

- **Headwater Catfish (*Ictalurus lupus*)**: originally throughout streams of the Edward's Plateau and the Rio Grande basin, currently limited to Rio Grande drainage, including Pecos River basin. Occurs in springs, and sandy and rocky riffles, runs, and pools of clear creeks and small rivers.

TPWD recommends avoiding construction during the spawning period of the Guadalupe Bass, if feasible. As the Headwater Catfish is believed to be limited to the Rio Grande drainage, construction activities should have no adverse effect on this species. Initial surveys will be conducted to mark the presence/absence of native freshwater fish species. Any native freshwater fish species that are observed will be relocated upstream away from construction activities. Handling and relocation of freshwater fish will follow TPWD protocols as outlined in Section 6.0.

According to the United States Geological Survey's Exotic Database, the following five exotic or invasive species of fish have been recorded along the project pathway or downstream from project activities:

- Threadfin Shad (*Dorosoma petenense*) – Native/Invasive
- Inland Silverside (*Menidia beryllina*) – Native/Invasive
- Wiper Hybrid (*Morone chrysops x M. saxatilis*) – Native/Invasive
- Rainbow Trout (*Oncorhynchus mykiss*) – Native/Invasive
- Pirapatinga, Red-bellied Pacu (*Piaractus brachypomus*) – Exotic/Invasive

Only the Red-bellied Pacu is considered an invasive, prohibited, and exotic species by TPWD and if found during initial surveys, shall not be relocated. However, as the other four species are native to other parts of Texas and the US, approval must be given by the TPWD before relocating individuals to a new site. The best way to ensure that no inadvertent possessing, transporting, or introducing aquatic invasive species occurs is to follow the general BMPs discussed in Section 8.0.

6.0 Freshwater Fish Handling and Relocation Protocols

A Freshwater Fish Handling and Relocation Protocol will also need to be implemented before construction activities commence. Any freshwater fish or aquatic life that is caught in a coffer dam (Option 1 or Option 2) will need to be relocated to a new site. It is important to note the protocol addresses proper handling and relocation techniques as aquatic species can experience many stressors which can lower rate of survival during catch and release activities. The TPWD lists the following stressors that surveyors need to be aware of during handling and relocation procedures:

- Behavior stress- crowding
- Handling stress- capture, struggle, confinement
- Exercise stress- prolonged swimming, being chased
- Temperature stress- change in temperature
- Salinity stress- removal from the water/low oxygen
- Toxicity stress- exposure to ammonia

These stressors can cause a primary response of stress by the releasing of hormones into the blood causing a disturbance to the physical state of the fish. The secondary stress responses are disturbances to osmoregulation, blood chemistry, metabolism, and immune system. These effects can reduce the fish's resistance to fungal and bacterial infections that lead to mortality in some cases. The TPWD emphasizes the need for proper care and procedures when catching and releasing aquatic life in order to minimize these stressors and increase chance of survival. The TPWD's recommendations for handling, maintaining, and transporting freshwater fish are listed

below. Estimated time expected to complete the collection and relocation activities is dependent on construction method and survey acreage for pipe installation.

TPWD Handling, Maintaining, and Transporting Aquatic Life Guidelines:

Fish

- Catch the fish fast and efficiently. As the fish resists capture, its oxygen demand increases. The fish will need oxygen to recuperate after the capture. Therefore, keep the water in the transport basin well aerated.

- If a landing net is used, rubber netting works best for minimizing mucous loss. Cloth and nylon type dip nets disrupt the protective mucous coating, disturb scales, and increase the possibility of injury or secondary infection that usually results in fish mortality.

- Help keep the protective mucous coat and scales of the fish from rubbing off by using wet hands when handling fish.

- Keep handling of the fish to a minimum. If at all possible, do not grab fish with hands. Instead, go directly to the transport basin. Avoid excess handling and/or dropping of the fish on the ground and the floor of the boat.

- Help keep the protective mucous coat and scales of the fish from rubbing off by using wet hands when handling fish. NovAqua ® or StressCoat ® can be added to the water in holding tanks to help mitigate the abrasive damage of capture and handling to the external mucous coating.

- Keep the fish in the water as much as possible to reduce stress. As a rule, keep the fish out of water no longer than you can hold your breath. Fish can suffer from brain damage from prolonged loss of oxygen.

- Water temperatures above 84° Fahrenheit tend to be stressful for warm water fish. Therefore, adding ice to the transport basin can minimize stress.

- Avoid overcrowding fish in the transport basin. A good rule of thumb to use would be to place no more than 5 fish in the 15"-20" range for a 120 quart cooler equipped with some type of an aeration system. Plan on 25% water exchange every 20-30 minutes. About 7.5 gallons (1.5 buckets if using a five gallon bucket). Use common sense, the more fish (>5) and the longer they sit in the transport basin, the more frequent water exchanges need to occur.

- Livewells or other holding tanks should be fitted with a water recirculation system. Oxygen cylinders are expensive, but provide the best aeration while maintaining water temperature.

- Run the aeration system continuously! Transport basins should be filled with ambient water to aid in acclimating the fish to the transport conditions.

Transport water used for relocation, should have an oxygen concentration between 5.0 - 7.0 mg/L. Water with oxygen levels lower than 4.0 mg/L can cause stress and eventually lead to a fish kill. Freshwater fish require water to have a pH range of 6.5 – 8.0.

7.0 Disposal of Dead Fish and Shellfish

Dead fish and shellfish, including exotic and invasive species, found on Project site before and during construction activities will need to be properly documented and disposed of. Documentation needs to include the species and number of individuals found dead, or disposed of, including the lengths (inches) of all fish for both native and non-native species. Per TPWD, dead animals including fish, are classified as municipal solid waste and should be disposed of in a landfill.

8.0 Best Management Practices

The water bodies, the North Concho River and Sulphur Draw, will be crossed for pipeline installation. During construction, no vehicle should attempt to cross Sulphur Draw. Depending on installation method across the North Concho River, care and proper dewatering techniques should be employed prior to vehicle crossing. Construction on Sulphur Draw will involve boring for pipeline installation, while pipeline installation across the North Concho River will involve either laying pipeline on the river floor or trenching. If practicable, access to either side of the project should be driven to by existing established roadways, bridge, or culvert structures. During construction activities on the river and draw, BMPs (discussed below) should be used to reduce sediment erosion to help with overall impact to habitat health and to prevent or minimize the risk of accidentally possessing or transferring controlled exotic species or pathogens. Per TPWD, there is a responsibility to ensure that Project personnel are not accidentally possessing, transporting, or introducing controlled Aquatic Invasive Species (AIS) to a new location. In addition, implementing BMPs will help prevent transfer of non-prohibited AIS as well as harmful algae or pathogens that could negatively impact native species.

8.1 Sediment Erosion BMPs

Physical barriers that could be used are silt fences, staked hay bales, sand bags, fiber logs, rock berms, earth dikes, drainage swales, sediment traps, check dams, subsurface drains, pipe slope drains, level spreaders, storm drain inlet protection, rock outlet protection, reinforced soil retaining systems, gabion, trench plugs, or other suitable erosion control devices. These may be used if necessary to intercept and retain small amounts of sediment carried by sheet flow from the disturbed areas during construction activities in order to prevent sediment runoff from the project site. These devices may be placed in any areas where high surface runoff is expected and where warranted within designated sensitive zones. They may be placed perpendicular to the flow of runoff and parallel to the contours if necessary. The devices will be utilized at stream banks and storm-drain inlets adjacent to work areas.

If equipment needs to enter and exit the work zone within the project crossing area, movable BMPs can be utilized as a physical barrier. The most common movable BMP are un-staked hay bales that construction crews can move for equipment and then replace at the end of the work day.

Heavy equipment will also need construction mats to minimize ruts and soil compaction. Construction mats should be placed perpendicular to the flow of traffic and have no gaps existing between boards. If necessary, place additional reinforcement for extra stability and to minimize the amount of sediment that could fall between spaces.

If a sediment control fence is used, it should be buried at least six inches and be at least 24 inches above ground. Construction personnel are encouraged to examine the inside of the fenced area to determine if any wildlife species have been trapped inside and provide safe egress opportunities prior to initiation of construction activities.

For soil stabilization and/or revegetation of disturbed areas, no-till drilling, hydromulching, and/or hydroseeding methods should be utilized opposed to erosion control blankets or mats. If erosion control blankets or mats are used, the product should contain no netting or contain loosely woven, natural fiber netting in which the mesh design allows the threads to move, therefore avoiding entanglement hazards to wildlife species. Plastic mesh netting should also be avoided.

8.2 TPWD Prevention of Aquatic Invasive Species Spread BMPs

During surveys, introductions, and relocations, do not transfer water from Project site to a new site unless specifically approved by TPWD. Use nets to transfer fish to help minimize water transfer whenever possible.

To help reduce accidental transfer of AIS, TPWD recommends a thorough cleaning of all equipment used to remove mud, plant fragments, and other debris before leaving the Project site such as: nets, mesh bags, buckets, boot tread, waders, snorkel/SCUBA gear, boats, trailers, vehicles, and any other equipment used in or adjacent to the water. Ensure that all equipment that could harbor plant fragments, such as boot tread, has been thoroughly rinsed of all possible debris using a gallon jug of water and a scrub brush or scraper. If available use a high-pressured hose or spray nozzle and water hose to clean equipment.

Make sure that all water has been drained from boats, fish hauling units, buckets, or any other equipment used to store or haul water from the Project site at a location where the water will not drain into any water body.

To further clean equipment of contamination, soak equipment with 10% bleach solution (i.e., 1 part household bleach to 9 parts water) for 10 minutes followed by a thorough rinse before drying. This procedure can help to prevent transfer of AIS such as zebra mussel larvae, golden algae, and fish pathogens, such as viruses, and should neutralize any hidden snails or plant fragments. Milder disinfectants (e.g., 1% Virkon Aquatic® for 10 minutes) or a 20-30 minute soak in very hot tap water (at least 110˚F) can help decontaminate nets or equipment that bleach could damage. Make sure all equipment is completely dry before use in another water body.

Vehicles used on project site that have been driven in the water or in mud adjacent to the water can easily harbor and transport AIS and need to be checked thoroughly, removed of all vegetation, rinsed well with a spray nozzle, and allowed to dry completely before visiting another water body.

9.0 Recommendations

Environmental needs for the project crossing at North Concho River will be dependent on the method of pipe installation. Based on the options lined out in the TEHA report previously done, the pipe will be installed using one of two different methods: laying the pipe on the river bed (Option 1), or trenching using isolated coffer dams for dewatering (Option 2). Initial mussel surveys will be required for all installation methods prior to construction activities. The survey areas will cover the Project crossing portion to be dewatered and an additional 50 m upstream and 100 m downstream. Impact avoidance measures for all aquatic species, primarily fish and mussel species, regardless of state-listing status, need to be considered during project planning and construction activities.

The North Concho River had been designated as an Ecologically Significant Stream Segment (ESSS) by TPWD. TPWD highly recommends avoiding impacts to ESSSs and the organisms inhabiting them during construction activities to the extent feasible.

10.0 References

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11.0 Maps

Map 1: USGS Topographic Map

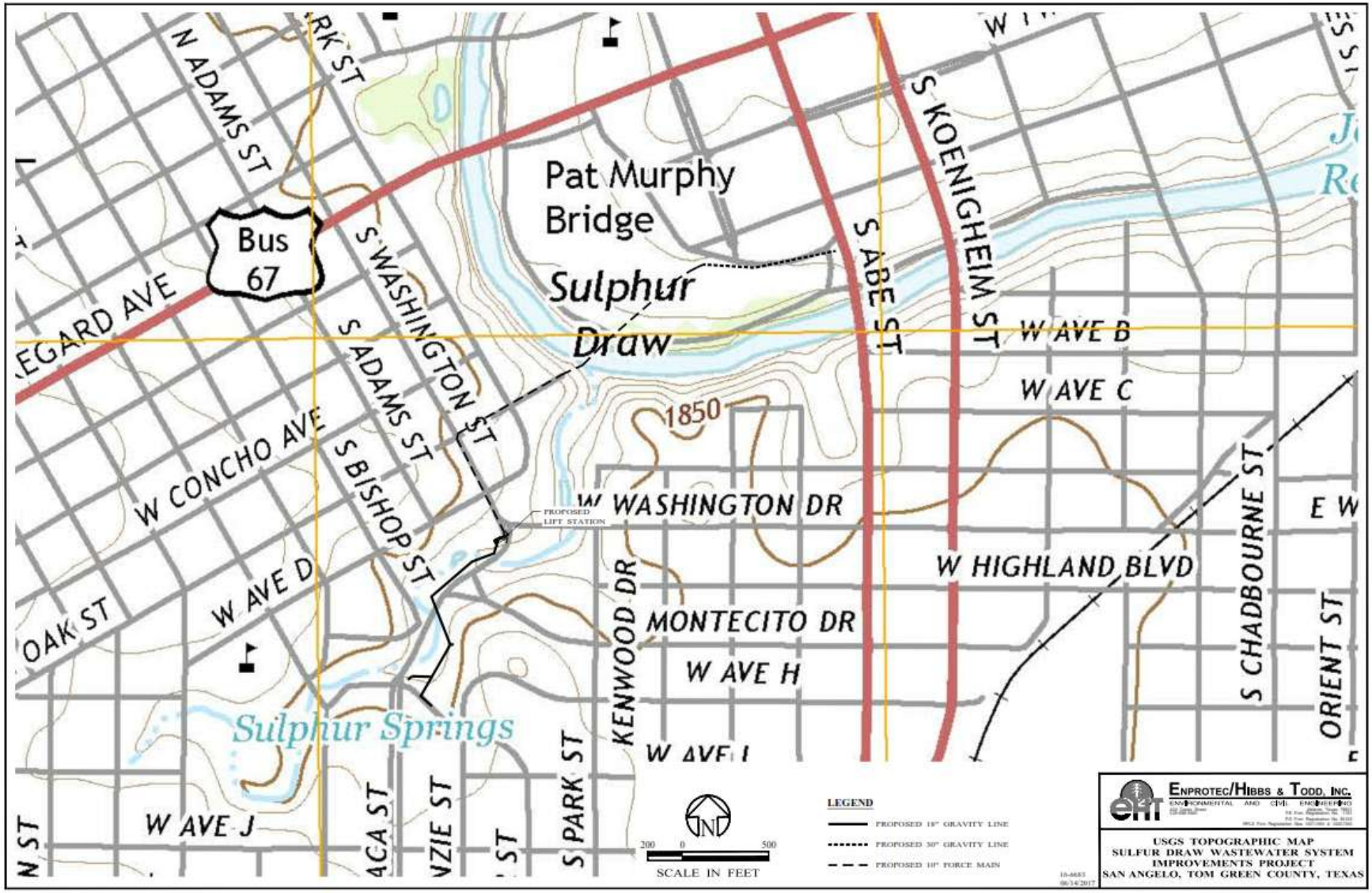
Map 2: Exhibit “A” 20’ Wide Utility Easement Map

Map 3: Exhibit “B” 20’ Wide Utility Easement Map

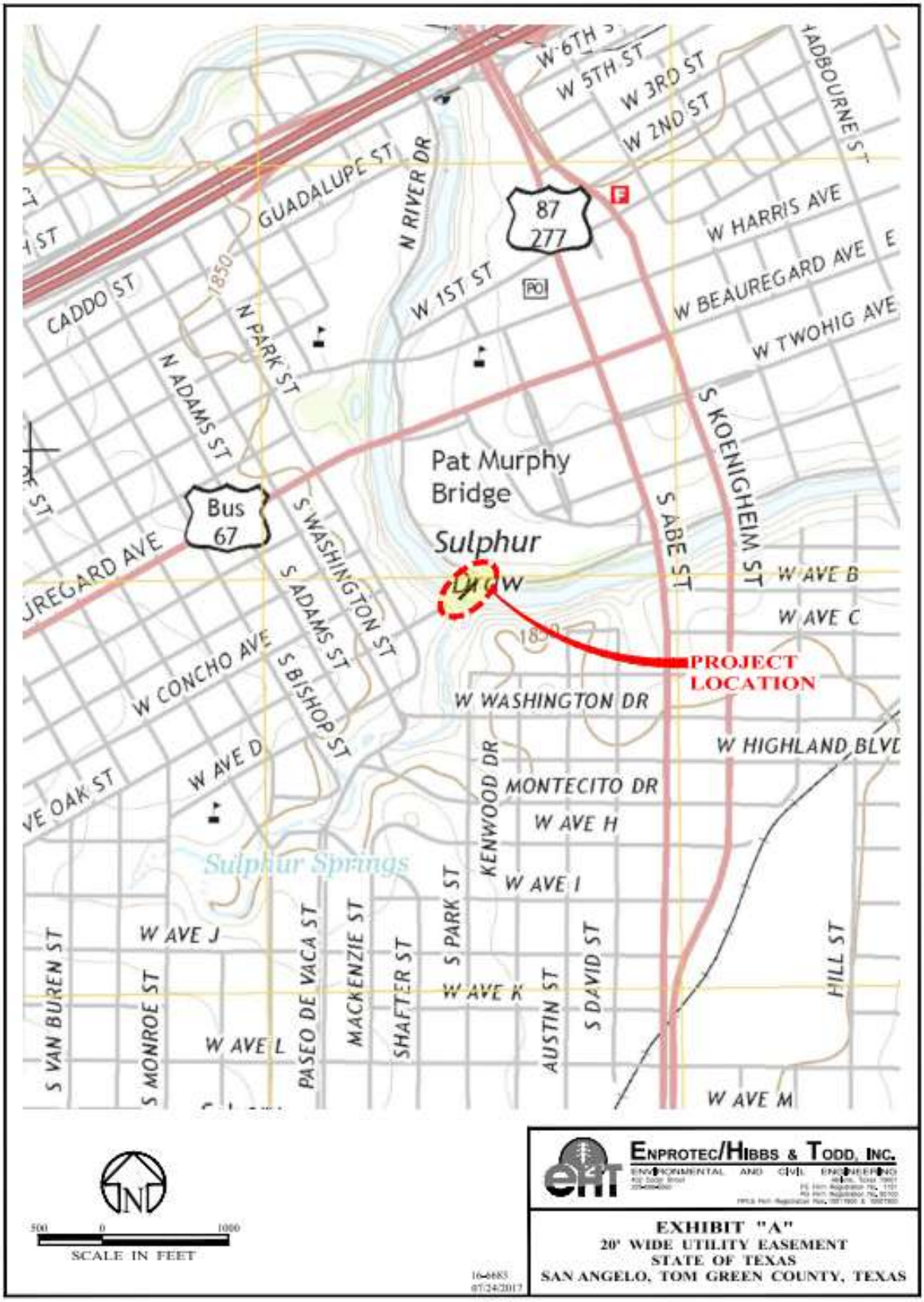
Map 4: Exhibit “C” Base Bid Map

Map 5: Exhibit “C” Alternate Bid #1 Map

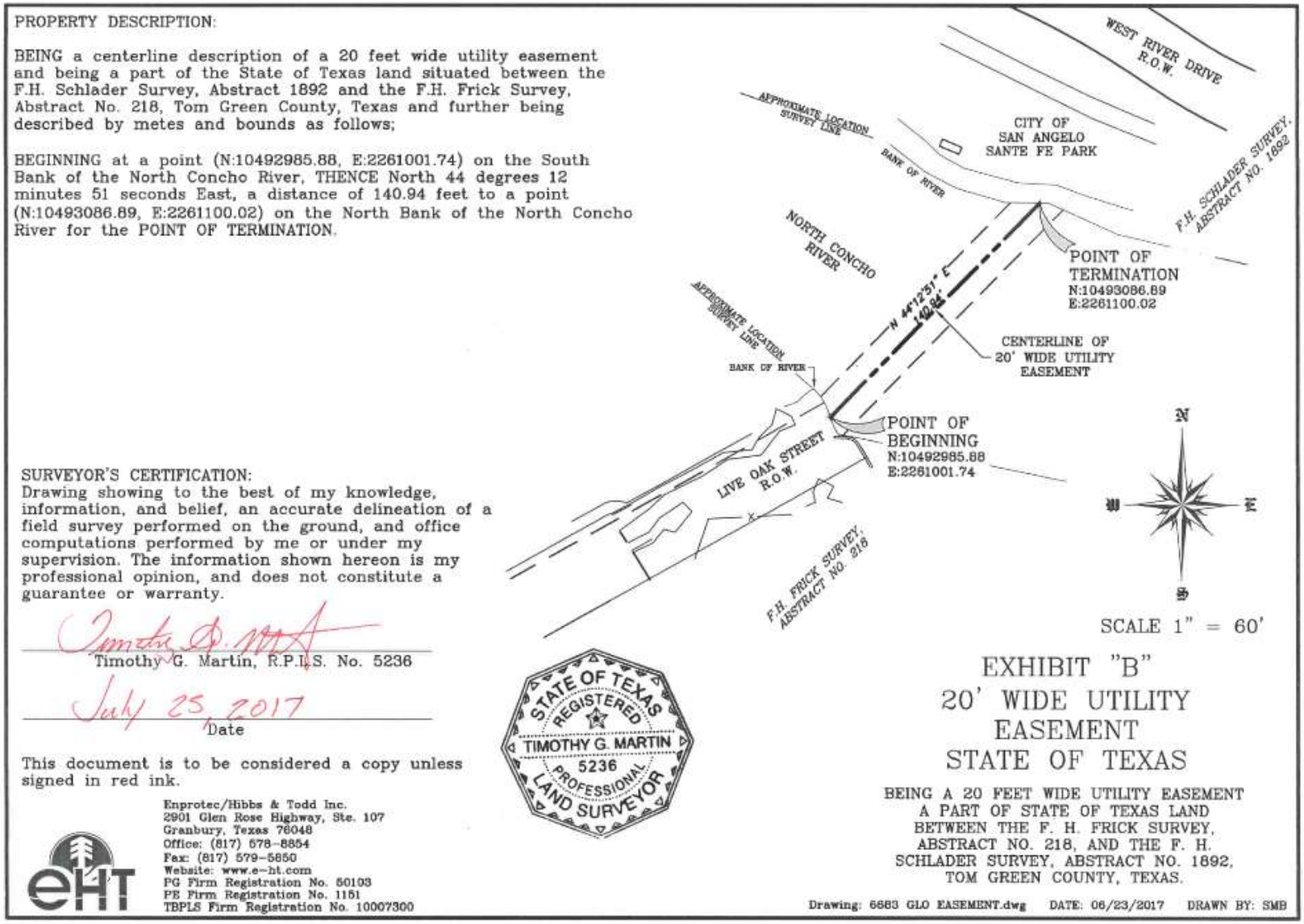
Map 1: USGS Topographic Map



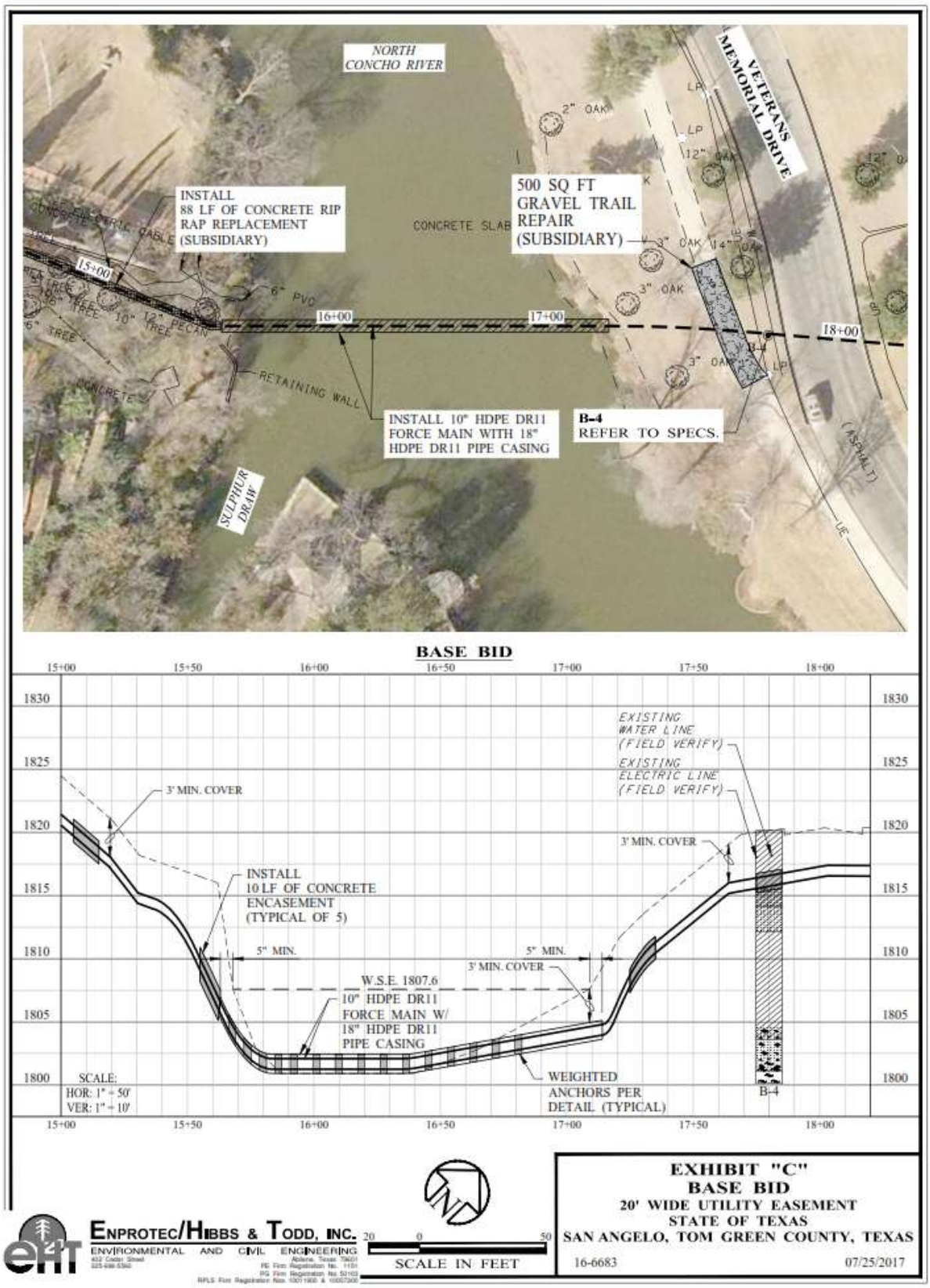
Map 2: Exhibit "A" 20' Wide Utility Easement Map



Map 3: Exhibit "B" 20' Wide Utility Easement Map



Map 4: Exhibit "C" Base Bid Map



Map 5: Exhibit "C" Alternate Bid #1 Map