CITY OF SAN ANGELO, TEXAS

TECHNICAL SPECIFICATIONS
FOR
AVENUE P DETENTION BASIN

Brenda Gunter
Mayor

COUNCIL MEMBERS

Tommy Hiebert
Single Member District #1
Tom Thompson
Single Member District #2
Harry Thomas
Single Member District #3
Lucy Gonzales
Single Member District #4
Lane Carter
Single Member District #5
Billie DeWitt
Single Member District #6

Daniel Valenzuela
City Manager
Lance Overstreet, P.E.
City Engineer
Allison Strube, P.E,
Water Utilities Director
Andy Vecellio, P.E.
Water Utilities Assistant Director

JULY 2019

PREPARED BY:

2732 82ND STREET, SUITE A
LUBBOCK, TX 79423
Phone - (806) 686-2700
Fax - (806) 686-2707
FIRM F-2144

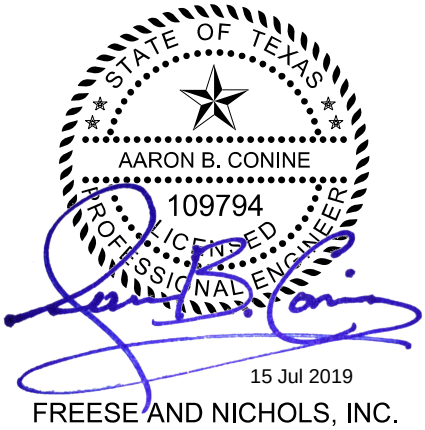
SAN18286

SEAL SHEET

Section: Drainage

FREESE AND NICHOLS, INC.
TEXAS REGISTERED
ENGINEERING FIRM
F-2144

Section: Water and Wastewater



FREESE AND NICHOLS, INC.
TEXAS REGISTERED
ENGINEERING FIRM
F-2144

Section: Structural

FREESE AND NICHOLS, INC.
TEXAS REGISTERED
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4.0 – Bid Sheet General Guidelines

Item No.	Item	Description
1	Removal of Temporary Backfill	See Technical Specification 4.3 Existing temporary backfill shall be removed to the top of the embedment zone, unless otherwise directed by the OWNER.
2	Bedding Material	Excavated material shall not be used as bedding material. All 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. The embedment zone for the utility pipe shall be Type II for installation with a minimum of thirty inches (30") of cover at finished grade unless otherwise noted in the plans and/or specifications. Piping with less than thirty inches (30") of cover at finished grade shall have Type V embedment unless specified by the OWNER. Bedding material shall be a granular material that will remain firm and not permit displacement of the pipe either during pipe laying and backfilling or following completion of construction. The crushed gravel meeting the requirements of ASTM Designation C33, Gradation 67 (3/4 in. to No. 4). Crushed stone or pea gravel meeting the TXDOT Grade 5 gradation per test method Tex-200-F, Part I and Turner Pit "D-bedding" are acceptable. Bedding material on all subaqueous installations shall consist of one inch (1") non-angular washed river gravel.
3	Provide Flexible Base for Backfill	See Technical Specification 4.6 This bid item is for the cost of backfill material alone.
4	Placement and Compaction of Trench Backfill	See Technical Specification 4.3 Backfill operations are to extend from the top of the embedment zone to a prescribed surface. This item shall cover all cost associated with the placement and compaction of the backfill material from item 3. Backfill operations shall be accomplished without disturbance of proximate utilities or improvements. The OWNER reserves the right to require density control procedures and density control testing for backfill under the scope of this specification without any additional cost to the OWNER.
5	Removal of Sacrificial Flexible Base	If base material is filled to top of trench (i.e. level with street), and final paving surface is ready to be placed, this bid item is to cover the removal of the necessary sacrificial base for the final paving surface.

6	Placement of Temporary Asphalt	Temporary Asphalt shall be put in place if final paving is not completed within seventy-two (72) hours on non-emergency backfills and "Emergency Repair Work". Temporary asphalt shall be a minimum of one inch (1") thick.
7	Hot Mix Asphaltic Concrete Pavement	See Technical Specification 4.7 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.
8	Hot Mix - Cold Laid Asphaltic Concrete Pavement	See Technical Specification 4.7 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.
9	Concrete Cap	See Technical Specification 4.45 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. All concrete shall be Class A (3,000 psi). 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.
10	Rigid Pavement	See Technical Specification 4.45 Rigid Pavement shall be used when specified by the OWNER and in repair of utility trenches cut in rigid pavement. The surface course shall be concrete pavement Class P (3,500 psi). Bend existing rebar into center of new concrete. Replace as necessary with #4 rebar on eighteen inch (18") centers each way and dowel in #4 rebar nine inches (9") deep with twenty-four inch (24") lap splice, or thirty-six pounds (36lbs) of Novamesh 850 per cubic yard with #4 rebar dowels nine inches (9") deep and nine inches (9") into the trench on eighteen inch (18") centers. Curing material capable of protecting the pavement from loss of moisture for a period of not less than seventy-two (72) hours shall be used. In order that the quality of the replacement pavement, reinforcement bars are to be placed as close to the initial positions as feasible. The concrete shall be properly placed and finished in accordance with OWNER specifications and shall be allowed to cure without disturbance for a period of not less than a twenty-four (24) hour cure time.

11	Provide & Place 6" Topsoil	See Technical Specification 4.33 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 source(s) shall be tested by the CONTRACTOR to ensure compliance with specifications. Topsoil shall be placed where directed by the OWNER.
12	Curb, Gutter, or Combined Curb & Gutter	See Technical Specification 4.44 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 (3,000 psi) concrete. Reinforcing steel will be repaired in those areas where the steel already exists, and shall be compatible with the existing sections. Membrane curing materials shall be applied.
13	Concrete Pad	Concrete Pad shall be a two feet (2') x two feet (2') concrete block around a valve box that shall be a minimum of five inches (5") thick. Concrete shall be Class A (3,000 psi) concrete. Detail is shown on "Fire Hydrant Installation" plan.
14	Hourly Rate for Site Clean-up	See Technical Specification 4.46 Areas in paved street roadways or alleys disturbed during construction shall be scraped and broomed, as necessary, and left in a clean and neat condition to the satisfaction of the OWNER. No direct compensation will be made for this work. Areas beyond the paved street roadway or alley disturbed during construction shall be scraped, raked, graded or broomed, as necessary, and left in a clean and neat condition to the satisfaction of the OWNER. Compensation for this work shall be at the hourly rate as bid on this item in the bid schedule. All site clean-up shall be done before final acceptance of construction will be considered.
15	Trench Spoil Removal	See Technical Specification 4.46 Trench spoil is either spoil material removed from the trench by the OWNER or unsatisfactory backfill material left on site by the OWNER outside of the trench repair boundaries. This material will not include Temporary Backfill. The CONTRACTOR will remove and dispose of this material unless otherwise directed by the OWNER.
16	Emergency Repair Mobilization Fee	Fee applied to all "Emergency Repair Work", often referred to as "Emergency Backfill", to compensate for mobilization. Mobilization shall include all equipment, materials, manpower, and other resources required to 1) secure the present site to the satisfaction of the OWNER providing for public safety and convenience and 2) relocate crews, equipment and materials to the "Emergency Repair" site.

17	Hot Mix - No BF - 200 SF or less	See Technical Specification 4.7 When OWNER backfills trench properly and the only remaining item is final paving with hot mix, this item is used.
18	Hot Mix - No BF - 201 SF or more	See Technical Specification 4.7 When OWNER backfills trench properly and the only remaining item is final paving with hot mix, this item is used.
19	Rigid Pavement - No BF - 200 SF or less	See Technical Specification 4.45 When OWNER backfills trench properly and the only remaining item is final paving with rigid pavement, this item is used. The surface course shall be concrete pavement Class P (3,500 psi). Bend existing rebar into center of new concrete. Replace as necessary with #4 rebar on eighteen inch (18") centers each way and dowel in #4 rebar nine inches (9") deep with twenty-four inch (24") lap splice, or thirty-six pounds (36lbs) of Novamesh 850 per cubic yard with #4 rebar dowels nine inches (9") deep and nine inches (9") into the trench on eighteen inch (18") centers. Curing material capable of protecting the pavement from loss of moisture for a period of not less than seventy-two (72) hours shall be used. In order that the quality of the replacement pavement, reinforcement bars are to be placed as close to the initial positions as feasible. The concrete shall be properly placed and finished in accordance with OWNER specifications and shall be allowed to cure without disturbance for a period of not less than a twenty-four (24) hour cure time.
20	Rigid Pavement - No BF - 201 SF or more	See Technical Specification 4.45 When OWNER backfills trench properly and the only remaining item is final paving with rigid pavement, this item is used. The surface course shall be concrete pavement Class P (3,500 psi). Bend existing rebar into center of new concrete. Replace as necessary with #4 rebar on eighteen inch (18") centers each way and dowel in #4 rebar nine inches (9") deep with twenty-four inch (24") lap splice, or thirty-six pounds (36lbs) of Novamesh 850 per cubic yard with #4 rebar dowels nine inches (9") deep and nine inches (9") into the trench on eighteen inch (18") centers. Curing material capable of protecting the pavement from loss of moisture for a period of not less than seventy-two (72) hours shall be used. In order that the quality of the replacement pavement, reinforcement bars are to be placed as close to the initial positions as feasible. The concrete shall be properly placed and finished in accordance with

		OWNER specifications and shall be allowed to cure without disturbance for a period of not less than a twenty-four (24) hour cure time.
21	Rigid Pavement Removal	Removal of boxed area one foot (1') outside widest trench openings. Removal shall include areas where cracks may have occurred from trench excavation.
22	Concrete Cap and Removal	See Technical Specification 4.45 This item includes all concrete capping of utility lines. Concrete cap shall be installed per the request made by OWNER. In the case, existing concrete capping has been damaged (i.e. cracks), damaged capping shall be removed and replace according to specifications.
23	Saw Cut Asphaltic Pavement	All cuts shall be one foot (1') outside trench width.
24	Saw Cut Concrete Pavement	All cuts shall be one foot (1') outside trench width.
25	Trench Safety	See Technical Specification 4.4 Submit to the OWNER a Trench Safety System Plan sealed by a registered Professional Engineer licensed in the State of Texas. Implement and maintain the provisions provided in plan throughout the duration of the contract.
26	Paint Fire Hydrants	See Technical Specification 4.38
27	Install New Fire Hydrant Assembly	See Technical Specification 4.13

4.1 - General Notes

4.1.1 Utility trenches extending into paved streets shall be completely repaired (including asphalt) as soon as possible after utility line installations are complete.

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

4.1.3 It shall be the CONTRACTOR's responsibility to familiarize himself/herself with the location of controlling water valves in an area prior to commencing construction in that area.

4.1.4 Where unpaved driveways are disturbed by construction operations, CONTRACTOR shall back-slope, grade and surface with a minimum of six inches (6") (unless existing base material is thicker) of base material to the right-of-way line as necessary to restore to original or better condition. Pay is subsidiary to other bid items.

4.1.5 Where paved driveways are disturbed by construction operations, CONTRACTOR shall repair in accordance with the City of San Angelo specifications.

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

4.1.7 Wet connections occurring during utility line installation will not be paid for but are considered subsidiary to the item being constructed.

4.1.8 Wet taps of existing water lines will be by the CONTRACTOR. The CONTRACTOR shall perform all excavation and supply and install all tapping saddles, valves and other materials. Wet taps will be paid at the quote provided by the CONTRACTOR in the bid form. Connections to existing lines not itemized on the bid form will be subsidiary to line installation.

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

4.1.10 Bacteriological testing will be the responsibility of the CONTRACTOR. The CONTRACTOR shall select a lab that is certified with the Texas Commission of Environmental Quality for Bacteriological analysis and submit for OWNER acceptance. The CONTRACTOR will have the accepted lab collect the field samples in the presence of the OWNER, and have analytical results faxed to the OWNER at 325-655-6397.

4.1.11 Flushing of Mains/Test Water: All water flushed from a main shall be contained and not allowed to discharge onto the ground unless specifically authorized by the OWNER. The CONTRACTOR may discharge water into a City of San Angelo owned sewer manhole with the OWNER's approval and only at such flow rates as allowed by the OWNER. Any discharge or disposal of water shall be in compliance with all State and Federal regulations.

4.1.12 For all valves installed under this contract, the CONTRACTOR shall etch valve locations (direction and distance) into curb and gutter. All lettering and numbering shall be a minimum of three inches (3") in height.

4.1.13 All process control operations including but not limited to operating isolation valves, disinfecting mains, turning on/off customer service valves, and taking chlorine residuals and microbiological samples must be under the direct supervision of a person with a Class D water license or higher. The CONTRACTOR is responsible for providing individuals with these classifications for supervision of the work. The CONTRACTOR must submit a list of licensed individuals to the OWNER for approval before any work may be performed on the OWNER's distribution system.

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

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

4.1.16 Pavement Cuts in High Traffic Areas: Pavement cuts in high traffic areas shall be backfilled and a temporary asphalt patch placed to stabilize the cut within forty-eight (48) hours of start of construction. These areas are note on the Plans with a "Note 17".

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

4.1.18 Preliminary Project Phasing has been provided as part of the plans. Project Phasing shall be the responsibility of the contractor.

CONTRACTOR shall not vacate higher priority location until work is complete (i.e. A working crew shall be present at the highest priority incomplete location until lines at that location are fully in service and trenches are drivable.).

Conditions at time of notice to proceed may dictate changes to schedule.

4.1.19 For each section within the project, once construction begins, the CONTRACTOR shall designate a crew to remain on site during standard working hours, until all work has been completed. A section shall be each area noted in the "Approximate Breakdown of Quantities" below. This note shall also apply to work being conducted at each individual Fire Hydrant Replacement, Water Quality Sampling Station and water meter change-out, if applicable.

4.1.20 Following is the Approximate Breakdown of Quantities. An Approximate Breakdown of Quantities has been provided as part of the Price Proposal.

4.1.21 Some or all water meters may contain Automatic Meter Readers (AMR). An AMR consists of a meter body, register, M.I.U. box, antenna, and associated wiring. CONTRACTOR shall be trained by the OWNER (City of San Angelo Staff) prior to working on or around any

meter boxes. Antenna wiring may be disconnected from M.I.U. boxes but must be reconnected according to the manufactures requirements. OWNER will provide wire connectors. The CONTRACTOR is responsible for any damages to an AMR. If an AMR is damaged, the CONTRACTOR shall pay $220.00 per each unit damaged to cover replacement and labor. All damaged AMRs shall be reported immediately to the OWNER.

4.1.22 Backfilled trenches shall be finish paved within two weeks of backfilling or the CONTRACTOR shall place and maintain temporary cold mix paving until final paving is accomplished.

4.1.23 All valves and fittings shall be made in U.S.A.

4.1.24 The minimum frequency for utility pipeline trench compaction test is as followed.

- Granular embedment max density proctor: Perform test once per source
- Soil proctor: Perform test once every 500 LF of every soil type change
- Pipeline embedment densities: Perform test once each lift every 300 LF
- Above pipe zone density: Perform one test at every 200 feet or at every 300 CY as directed by the City (not by lifts but by length/quantity)

Density and/or compaction testing is required and it is the responsibility of the Contractor. Prior to the pre-construction meeting, the Contractor shall submit the name of the independent testing and laboratory to be used for the City's review and approval. Cost of testing shall be subsidiary to the appropriate bid items. City will perform QA/QC testing at City's own cost and discretion.

4.1.25 All abandonment of pipeline under proposed pavement shall be grouted to include the 18-inch sanitary sewer being abandoned on Sheet SS-15. All abandonment of pipeline outside of proposed pavement with the exception of the 18-inch sanitary sewer, shall be cap and plug and grouting is not required.

4.1.26 City would like to retain the removed asphalt. Asphalt does not need to be milled and can remain in large chunks. Deliver asphalt to the City's Yard on St. Ann Street.

4.1.27 Drill seeding shall be accomplished for all unimproved surfaces within right-of-way and easements and as directed by the City.

4.1.28 If flex base is used as backfill, any additional cost shall be the responsibility of the Contractor and shall not be passed on to the City.

4.1.29 The site is very dense to hard at depths deeper than 5 feet below existing ground surface. Heavy duty equipment may be required if excavations extend into the dense material. In the area of Boring B21, (Lowrie Avenue and La Follette), a conglomerate layer was encountered and hard excavation will most likely be required in that area.

4.1.30 All valves and fire hydrants that are part of the tie-in process and installation work shall be salvaged. If a valve is marked to be removed and salvaged but is not uncovered as part of the excavation during the installation of proposed utility improvements, then the valve may be abandoned in place.

4.1.32 All references to construction time shall be updated to 18 months or 540 days.

4.1.33 Per TCEQ Chapter 217, all portions of the manhole within nine feet of a water supply pipe encased in at least one foot of cement stabilized sand shall the meet the following requirements:

- Include at least 160 pounds of cement for every cubic yard of sand.
- Be installed beginning one-quarter pipe diameter below the centerline of the collection system pipe.
- Be installed ending one full pipe diameter above the top of the collection system pipe, or 12 inches above the top of the collection system pipe, whichever is greater.

4.2 - Temporary Facilities

4.2.0 General

4.2.1 Office at Site of Work

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

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

4.2.2 Water

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

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

4.2.3 Power

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

4.2.4 Telephone Service

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

4.2.5 Sanitary Facilities

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

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

4.2.6 Maintenance of Traffic

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

4.2.7 Fences

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

4.2.8 Damage to Existing Property

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

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

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

4.2.9 Security

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

4.2.10 Access Roads

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

4.2.11 Parking

The CONTRACTOR shall provide and maintain suitable parking areas for the use of all construction workers and others performing work or furnishing services in connection with the Project, as required to avoid any need for parking personal vehicles where they may interfere with public traffic or construction activities.

4.2.12 Noise Control

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

4.2.13 Dust Control

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

4.2.14 Temporary Drainage Provisions

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

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

4.2.15 Pollution Control

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

4.2.16 Erosion and Siltation Controls

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

The inspection and maintenance of the erosion prevention measures shall be the contractor’s responsibility throughout all phases of the construction. All erosion control measures shall be in

place prior to any construction activities. They shall remain in place until after construction is complete and the site has been stabilized.

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

4.3 - Excavation and Backfill

4.3.0 General

4.3.0.1 Scope

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

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

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

4.3.1 Classification of Excavated Materials

All excavation shall be classified as either common excavation or rock excavation. Excavation and trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the contract work.

4.3.1.1 Common Excavation

Common excavation is defined as the removal of all material which is not classified as rock excavation.

4.3.1.2 Rock Excavation

Rock excavation is defined as the removal of all materials which, by actual demonstration, cannot in the OWNER's opinion, be reasonable excavated with a ¾ yard 336 Caterpillar Excavator equipped with a thirty feet (30') boom, heavy duty rock ripping bucket, or similar approved equipment.

The OWNER reserves the right to waive the demonstration of the material encountered as well defined rock. The term "rock excavation" shall be understood to indicate a method of removal and not a geological material. In addition, rock excavation may include removal of well-defined rock by the method of mechanical splitting. In the areas where rock removal is required, Technical Specification 4.43, "Vibration Monitoring Specification," shall be followed.

No payment will be made under "Rock Excavation" for any method of rock removal other than mechanical splitting. Measurement shall be the depth per linear foot. The depth is the

difference in elevation between the theoretical bottom of bedding and the top of the original rock. The length or linear foot will be measured horizontally along the centerline of the trench.

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 consent of the OWNER.

4.3.4 Unauthorized Excavation

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

4.3.5 Dewatering

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

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

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

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

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

4.3.6 Stabilization

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

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

4.3.7 Earth Fills and Embankments

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

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

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

4.3.8 Subgrade Preparation

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

4.3.9 Placement and Compaction

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

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

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

4.3.10 Granular Fills

Granular fills shall be provided where required. Granular fills shall be placed on suitably prepared subgrades and compacted by vibration. Granular fill material shall be pea gravel, well

graded and clean, 2-inch to No.4, meeting all requirements of ASTM C33. Crushed limestone will not be permitted. Granular fill shall be compacted to eighty percent (80%) relative density as determined by ASTM 2049.

4.3.11 Unsuitable Foundation Material

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

4.3.12 Trench Excavation

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

4.3.13 Minimum Cover

Where pipe grades or elevations are not definitely fixed by the contract Plans, trenches shall be excavated to a depth sufficient to provide a minimum depth of thirty inches (30”) of backfill cover over the top of the pipe, including coupling or bells.

4.3.14 Limiting Trench Widths

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

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

4.3.15 Compacted Backfill

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

a) Where beneath surface construction, structures, or streets.

b) Where in future street right-of-ways.

c) Where beneath fills or embankments.

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

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

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

4.3.16 Structure Backfill

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

No backfill shall be deposited or compacted in water. Particular care shall be taken to compact structure backfill which will be beneath pipes, surface construction, or structures. In addition, wherever a trench is to pass through structure backfill, the structure backfill shall be placed and compacted to an elevation not less than twelve inches (12") above the top of pipe elevation before the trench is excavated. Compacted areas, in each case, shall be adequate to support the item to be constructed or placed thereon.

4.3.17 Final Grading and Placement of Topsoil

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

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

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

4.3.18 Disposal of Excess Excavated Materials

Insofar as needed, suitable excavated materials shall be used. All excess excavated materials together with all debris stones, stumps, and roots shall be removed from the site and disposed

of by, and at the expense of, the CONTRACTOR. Excess material or material which cannot be made suitable for use in embankments will be declared surplus and shall become the property of the CONTRACTOR to dispose of offsite at a permitted fill site, without liability to the OWNER or any individual. Such surplus material shall be removed from the Work site promptly following the completion of the portion of the utility involved.

4.3.19 Shoring and Sheathing of Excavations

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

4.3.20 Settlement

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

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

4.3.21 Pavement Replacement

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

4.3.22 Concrete Blocking

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

4.3.23 Measurement and Payment

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

4.4 - Trench Safety Systems

4.4.0 General

4.4.0.1 Scope

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

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

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

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

4.4.1 Trench Safety System Plan Submittal

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

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

d) Certification of Completion of an OSHA-approved program indicating that the CONTRACTOR's Competent Person(s) has received training in "Excavation Safety".

4.4.2 Construction

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

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

4.4.3 Changed Conditions

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

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

4.4.4 Contractor's Responsibility

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

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

4.4.5 Measurement

Trench Excavation Protection shall be measured by the linear foot along the centerline of the trench.

4.4.6 Payment

All development, design, furnishing, installing the system, for dewatering, maintenance, replacement and removal of the Trench Safety Systems, for sloping, special clearing, excavation and work including material, plans and reports required to safely implement the trench safety system will be paid at the price bid and the units specified in the Bid Agreement Form for Trench Excavation Protection.

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 Lay 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) **Fertilizer** - Fertilizer shall conform to the requirements of Technical Specification 4.5.2, "Construction Methods," under "Fertilizer". The fertilizer shall conform to the specified analysis.

c) **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.

d) **Mulch** -

   a. 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.

   b. 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.

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

   d. 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.

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

f) **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 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 August 14th, or after a Cool Season Planting has been made, then the Warm Season Seeding Mixture should be planted. If construction is completed between August 15th 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
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.

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

Measurement and payment for this item will be based on the lump sum price bid. Payment includes full compensation for furnishing all materials, including water, mulching, tacking agents, fertilizer, seed, sod and for furnishing all labor, tools, equipment and all incidentals necessary to complete the work.

4.6 - Flexible Base (Backfill of Paved Areas)

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 percentage points 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.

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 - 0.35-gallon per square yard of surface, unless otherwise approved by the OWNER.

4.7.1.2 Tack Coat

The tack coat shall be asphaltic materials approved by the OWNER and shall meet the requirements of TXDOT Item 300, "Asphalts, Oils, and Emulsions."

4.7.1.3 Asphalt Concrete Material

The asphaltic concrete surface coat material shall be of TXDOT Type D hot mix asphaltic concrete or hot mix - cold laid asphaltic concrete 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 only if written permission is obtained from 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. The CONTRACTOR shall apply the asphalt at a temperature within 150º F of the temperature selected.

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 structure.

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 the necessary 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

Asphaltic Concrete Pavement will be measured per each square foot of material placed. The work performed and materials furnished in accordance with the Item and measured will be paid for at the unit price bid for "Hot Mix Asphaltic Concrete Pavement" or "Hot Mix – Cold Laid Asphaltic Concrete Pavement," depending on type used. This price shall be full compensation for securing any necessary source(s) and any royalty involved; for furnishing all materials, for all excavation, loading, hauling, stockpiling and placing; and furnishing all labor, tools, equipment and incidentals necessary to complete the work.

"Rolling" will not be paid for directly, but will be considered subsidiary to this Item, unless otherwise shown on Plans. Payment will not be made for any material which is used for purposes other than as required by this Item.

4.8 - Barricading Standards and Procedures

4.8 General

4.8.1 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. CONTRACTOR shall provide lighted barricades for use at night, and shall maintain all lighted barricades for the duration of the project.

4.8.2 Barricading Plan

The CONTRACTOR shall prepare and submit a barricading plan to the OWNER at the pre-construction conference. Plans shall be prepared 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.

4.8.3 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 twenty-four (24) hour basis, and shall provide a phone number where the responsible party can be reached on a twenty-four (24) hour basis.

4.8.4 Measurement and Payment

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

4.9 - Polyvinyl Chloride (PVC) Pressure Pipe

4.9 General

4.9.1 Scope

This section covers the furnishing and installation of all PVC 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.

4.9.2 Material Specifications

PVC Pipe shall be the integral bell, elastomeric seal-type and meet the following requirements:

Nominal Diameter	
(in.)	**Requirements:**
2" < d < 4"	ASTM D2241 IPS OD Pressure Rating 200, SDR 21 complying fully with all applicable ASTM Standards.
4" ≤ d ≤ 60"	AWWA C900 CIOD, DR18

PVC pressure pipe is to be manufactured from Class 12454 virgin compound as defined in ASTM D1784. All pipe shall bear the National Sanitation Foundation (NSF) seal for potable water pipe. In addition, C900 shall be listed with Underwriters Laboratories, Inc. (UL).

Pipe joints shall be spigot and integral wall section bell with a solid cross section elastomeric or rubber ring gasket conforming to the requirements of the latest revisions of ASTM D3139 and ASTM F477. Gaskets shall be factory-assembled and secured in place to prevent displacement. Lubricant shall be as recommended by the pipe manufacturer and shall not adversely affect the potable qualities of the water to be transported. Pipe and fittings shall be assembled with a non-toxic vegetable soap lubricant which also meets the pipe manufacturer's specifications. Joints shall meet the applicable sections of the latest revision of AWWA C111. Each length of pipe shall be clearly marked with the manufacturer's trade name, the size and class, and the specifications that it meets. Fittings used with PVC pipe shall be ductile iron and comply with requirements as stated in Technical Specification 4.12,"Ductile Iron Pipe and Fittings."

4.9.3 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 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 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.

4.9.4 Bedding Material for Water Pipe

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

4.9.5 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.

4.9.6 Joint and Pipe Testing

See Technical Specification 4.11, "Pressure Pipe Testing and Disinfection."

4.9.7 Blocking and Restraints

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

Mechanical restraints shall meet the requirements of AWWA C605, latest revision. Mechanical restraints (in addition to concrete blocking) shall be installed in the locations shown in the Drawing detail sheets. The devices shall meet the test requirements of the latest version of ASTM F1674 (formerly UNI-B-13) "Standard Test Method for Joint Restraint Products for use with PVC Pipe."

4.9.8 Wrapping of Ductile Iron Fittings

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

4.9.9 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.

Couplings shall be of a gasketed, sleeve type. Each coupling shall consist of a steel middle ring, two (2) steel followers, two (2) rubber compounded wedge section gaskets, and sufficient track head stainless steel bolts to properly compress the gaskets. Couplings shall be of the type to match piping on which installed. Couplings shall be Smith-Blair Type 442 or Mueller MaxiFit-Xtra.

4.9.10 Measurement and Payment

Payment for this item will be based on the linear feet price bid. 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 (other than valves), testing, disinfection, etc., in accordance with the specifications, Plans, and/or instructions of the OWNER.

4.10 - Valves and Valve Installation

4.10.0 General

4.10.1 Section Includes

a) Resilient Seat Gate Valves
b) Butterfly Valves
c) Gate Valves and Ball Valves
d) Air Release Valves

4.10.2 General Description

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

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

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

4.10.3 Resilient Seat Gate Valves

All valves four inches (4") through thirty-six inches (36") shall be non-rising stem resilient seat gate valves, unless otherwise shown on the Plans or directed by the OWNER, as manufactured by American Darling, East Jordan Iron Works, J&S, Mueller, M & H or U.S. Pipe. The valves shall be tested for zero leakage past the seat at 200 psi and hydrostatically shell tested at 400 psi. The valves shall be wedge disc type and shall contain a machined surface in the valve body with solid guide lugs on the disc that travel within channels cast in the sides of the valve. The valve shall contain a bronze stem nut and O-ring seals above and below the thrust collar with a thermoplastic anti-friction washer above the thrust collar. Interior and exterior of the valve shall be epoxy coated, 8 millimeters, dry film thickness, minimum. For each valve eighteen inches (18") and larger, the manufacturer shall provide an affidavit of compliance to

demonstrate compliance with AWWA C509. Results of the Shell and Seat Tests shall be included with each affidavit. The affidavit shall demonstrate that the valves are of recent manufacture and that the valves have been tested within ninety (90) days of receipt. The CONTRACTOR shall operate each valve prior to installation to ensure free and proper functioning. During the operation, the CONTRACTOR shall allow the OWNER the opportunity to visually inspect and to operate the valves.

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

~~4.10.4 Butterfly Valves~~

~~Butterfly valves shall be solid shaft type. All keys and pins used in securing valve discs to shafts shall be stainless steel. Valve body shall be high-strength cast iron ASTM A126 Class B with 18-8 Type 304 stainless steel body seat. Valve vane shall be high-strength cast iron ASTM A48 Class 40, having rubber seat mechanically secured with an integral 18-8 stainless steel clamp ring and 18-8 stainless steel nylon locked screws. Valve seats shall be 18-8 stainless steel. Shaft seals shall be O-ring type. The interior and exterior of the valve shall be epoxy coated, 8mil dry film thickness, minimum.~~

4.10.5 Valve Bodies

a) Clear Water Opening: The diameter of the clear waterway opening through the valve shall be not less than the rated size of the valve.

b) Flanges: Flanges shall be furnished to true plane surfaces within a tolerance limit of 0.005 inch; the finished face shall be normal to the longitudinal valve axis within a maximum angular variation tolerance of 0.002 inch per foot of flange diameter.

c) Mechanical Joint Ends: Where mechanical joint ends are specified, either mechanical joint or push-on ends conforming to ANSI A21.11 will be acceptable.

4.10.6 Valve Operations

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

4.10.6.1 Manual Operations

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

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

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

~~4.10.7 Gate Valves and Ball Valves~~

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

4.10.8 Valves Boxes

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

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

4.10.9 Air Release Valves

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

4.10.10 Pressure Reducing Valves

Pressure reducing valves shall be provided and installed by the CONTRACTOR at the locations as noted on the Plans. The pressure reducing valves shall be as specified on the Plans, or approved equal.

4.10.11 Drawings and Data

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

4.10.12 Installation

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

4.10.13 Measurement and Payment

Measurement and payment for this item will be based on the lump sum price bid. Payment will be full compensation for providing all materials, labor, machinery, blocking, valve box and incidentals needed for a complete in place facility.

4.11 - Pressure Pipe Testing and Disinfection

4.11.0 General

4.11.0.1 Scope

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

4.11.1 Testing

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

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

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

4.11.2 Chlorination

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

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

b) After twenty-four (24) hours, the solution shall be discharged from the line and flushed by water direct from the City of San Angelo main until the residual chlorine content is approximately the same as treated City of San Angelo water.

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

4.11.3 Water Service

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

Rehau Municipex is an acceptable material for the installation of new water service lines.

4.11.4 Measurement and Payment

No additional payment shall be made for material furnished or work done under this item, which is considered subsidiary of the various pay items. The disinfection tests for each section of pipe line will be the responsibility of the CONTRACTOR. Any additional tests required due to unsatisfactory quality of water will be the responsibility of the CONTRACTOR.

4.12 - Ductile Iron Pipe and Fittings

4.12.0 General

4.12.0.1 Section Includes

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

4.12.1 Material Specifications

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

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

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

4.12.2 General Installation

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

4.12.3 Pipe Handling

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

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

4.12.4 Mechanical Joints

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

4.12.5 Slip-on Joints

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

4.12.6 Flanged Joints

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

4.12.7 Blocking

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

4.12.8 Wrapping of Ductile Iron Pipe and Fittings

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

4.12.9 Lining and Coating

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

4.12.10 Connections with Existing Lines

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

4.12.11 Bedding

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

4.12.12 Measurement and Payment

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

4.13 - Fire Hydrants

4.13.0 General

4.13.0.1 Scope

Fire hydrants shall meet or exceed the minimum standard of AWWA Standard C-502 latest revision. Hydrants shall be traffic model with breakaway safety flange and stem coupling; "O" ring stem seals with sealed oil reservoir lubricating stem operation; compression type main valve 5-1/4 inch, closing with pressure; bronze seat ring shall thread into a bronze drain ring forming an all bronze drainway with positive sealing; and two bronze drain outlets; main valve gasket shall be 3/4 inch thickness 90 durometer neoprene; 1-1/2 inch all bronze pentagon operating nut with anti-friction washer opening left; two 1-1/2 inch hose nozzles and one 4-1/2 inch pumper nozzle with National Standard Hose Threads; openings shall be in line with each other. Hydrants shall have asphaltic base varnish on the outside of lower barrel and shoe. The inside of the shoe shall be epoxy coated, minimum eight (8) mils thickness. The Fire Hydrant shall be painted Sherwin Williams B54Y17 or 6170807, yellow, or equal. Hydrants shall be lowered into the trench, inspected, and joined to the pipe as specified. Reaction thrust blocking shall be provided for all hydrants. Hydrants shall be thoroughly cleaned prior to installation.

4.13.1 Location

Hydrants shall be located as specified on the plans or by the OWNER. Hydrants shall be located to provide complete accessibility and to minimize the possibility of damage from vehicles or injury to pedestrians. The following provisions shall govern unless the OWNER specifies otherwise:

a) The bowl of the hydrant placed behind the curb shall be set so that no portion of the hydrant or hose nozzle caps on the street side shall be less than twelve inches (12”) or more than forty inches (40”) from the face of the curb.

b) All hydrants shall be plumb.

c) Pumper nozzles shall be at right angles to and facing the curb.

d) The breakaway flange shall be at finish ground or curb level. It shall not be below or more than two inches (2") above the finished grade. If the hydrant exceeds these limits, it will not be accepted.

4.13.2 Connection to Main

Each hydrant shall be connected to the main with six inch (6”) pipe and shall be controlled by an independent six inch (6”) valve.

4.13.3 Drainage

Hydrants shall be set with a drainage pit. The pit shall be filled completely with coarse gravel or broken stone mixed with sand under and around the bowl of the hydrant to a level six inches (6”) above the drain opening. No hydrant drainage pit shall be connected to a sewer.

4.13.4 Measurement and Payment

Fire hydrants shall be shall be measured per each complete installed in place. Payment will be made at the unit price per each hydrant which includes the hydrants, the line from the main to the hydrant, the independent valve on the main, the hydrant installation and all miscellaneous fitting, blocking, materials, and labor for a complete working installation.

4.19 - Temporary Line Stops - Potable Water Mains

4.19.0 General

4.19.0.1 Scope

Under this item CONTRACTOR shall furnish all materials, labor, and equipment to properly install a Temporary Line Stop into the existing potable water mains at the locations shown on the plans.

4.19.1 Experience

The design, installation and operation of the temporary stop system shall be the CONTRACTOR's responsibility, unless otherwise noted. The system shall include all concrete blocking and supports required for the operation. The CONTRACTOR shall employ the services of a "Stop Sub-Contractor" who can demonstrate to the OWNER the experience and competence through a history of successful completion of similar projects. The "Stop Sub-Contractor" shall provide, upon request, at least five (5) references of projects of a similar size and complexity as this project performed in the past three years. Approved "Stop Sub-Contractor's" are:

- TDW Services, Inc.
- Furmanite America, Inc.

Requests to approve additional "Stop Sub-Contractor's" shall be submitted in writing to the Engineering Division, Department of Water Utilities at least fourteen (14) days prior to the original bid opening date. The request shall include the company's experience, references, list of similar projects, and a description of the equipment and methods employed.

4.19.2 Preliminary Field Inspection of Mains

Dimensional, specification, and other data regarding the existing mains are provided for CONTRACTOR's convenience only. These data must be verified by field inspections. In addition, it is anticipated that exterior main conditions, service connections, or presence of adjoining utilities may require relocation of proposed taps.

The CONTRACTOR shall field measure the exact main O.D., ovality, and cylinder diameter of each stop location. All measurements shall be obtained by exposing the full circumference of each pipe. For concrete steel cylinders pipe, the CONTRACTOR shall expose the entire circumference section of the internal steel cylinder at the Pressure Tap location(s) in order to obtain data on the existing pipe. The area shall be repaired by applying Portland cement mortar to the exposed cylinder, filling the recess flush with the O.D. of the main. Mortar will be allowed to harden before backfilling.

If, in OWNER's opinion the proposed location is unsatisfactory due to previously unknown connections or fittings or unsatisfactory pipe conditions, the CONTRACTOR will relocate and excavate at another site.

4.19.3 Interruption of Flow

The main shall be returned to service as soon as possible and the CONTRACTOR shall allow a minimum of twenty-four (24) hours between each stop, unless otherwise approved by the OWNER. The CONTRACTOR shall install a minimum of three taps onto the existing main (unless taps are contained on the insertion/tapping equipment). The taps shall be located such that the pressure on each side of the stop can be measured. The third tap shall be located between the stops and shall be located in the section of line that is to be removed unless an alternate location is approved by the OWNER. Taps sizes shall be a minimum of two inches (2”), larger sizes will require pre-approved by the OWNER. No work shall commence within the stopped area until the CONTRACTOR has sufficiently demonstrated to the OWNER that the stops have sealed sufficiently for the proposed work. CONTRACTOR is responsible for all outlets, valves, taps, etc. that may be required to sufficiently divert water that seeps through the stops in order to complete work specified within the stopped area. The CONTRACTOR shall obtain pre-approval from the OWNER for any fittings, outlets, valves, etc. that may be required to handle by-pass water flow from the temporary stops.

4.19.4 Reduction of Pressure

For concrete steel cylinder pipe, the entire operation of making the tap(s) shall be accomplished with the line of pressure operating at no more than the safety limit established by mathematical calculation of the hoop stress of the unsupported cylinder with the reinforcing (prestressing) wires removed. A safety factor of eighty percent (80%) of yield is normally used. This calculation will determine the maximum operating pressure at the time of the material installation and the tap.

4.19.5 Temporary Line Stop Fittings and Accessories

CONTRACTOR shall submit to OWNER five (5) sets of drawings, furnished by manufacturers, fully and distinctly illustrated and describing the tapping fittings, completion plug and any other fittings that are permanently attached to the main. Saddles shall conform to the following specifications; 304 stainless steel liner; rubber gasket suitable for use in potable water, with grid pattern glued in place to liner; 304 stainless steel armor plates bonded to liner; ductile iron flange or carbon steel with epoxy paint, with 150 lb. Drilling; rubber gasket suitable for use in potable water glued in place on flange face; 304 stainless steel hardware coated to prevent galling or seizing; 304 stainless steel test plug.

4.19.6 Installation of Temporary Line Fitting

CONTRACTOR shall power wire brush and grind the exterior of the main to remove any debris, corrosion deposits, or other surface irregularities that might interfere with proper seating and sealing of each tapping fitting against each main. Fittings shall be assembled onto the main following the manufactures’ requirements. The CONTRACTOR shall pressure test the stop fitting to verify satisfactory gland/cylinder seal. Test pressure shall not exceed line pressure in the main to avoid collapsing the cylinder and liner.

4.19.7 Thrust and Support Blocking

Prior to mounting tapping valve and pressure tapping machinery, CONTRACTOR shall install concrete thrust and support blocking as per the manufactures’ requirements. Blocking shall be allowed to reach the minimum cure strength specified by the manufacture before any valves or machinery shall be mounted onto the Stop fitting.

4.19.8 Cutting Operation

Drilling equipment shall be in good workable condition prior to initiation of work, and equipped with power drive to insure smooth cutting and to minimize shock and vibration. Cutting equipment shall be carbide tipped and capable of being renewed without removal from jobsite.

4.19.9 Temporary Line Stop Machinery

The equipment shall consist of folding plugging head that contains an elastomer sealing element. The plugging head is advanced into and from the main by means of a linear actuator. When retracted, the plugging head and carrier are housed in an adapter, bolted pressure tight between the tapping valve and the actuator. A minimum of one extra seal per line size and per stop shall be on-site.

4.19.10 Completion

The completion of the Stopping shall include the installation of the Completion Plug and a Blind Flange.

4.19.11 Measurement and Payment

Measurement and payment for this item will be based on the lump sum price bid. Payment will include full compensation for all trench protection, rock excavation, material, equipment, labor, and resources required for complete installation inclusive to the unit price bid.

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 four inches (4”) through fifteen inches (15”) diameter and latest revision of ASTM F679 PS 46 for diameters greater than fifteen inches (15”) in diameter. Pipe shall be SDR 26 if the pipe has less than thirty inches (30”) (unless pipe is protected by a concrete cap) or more than fifteen feet (15’) of cover at finished grade.

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. Fittings used with PVC pipe shall be ductile iron and comply with requirements as stated in Technical Specification 4.12, "Ductile Iron Pipe and Fittings" section.

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 thirty inches (30”) of cover at finished grade unless otherwise noted in the plans and/or specifications. Piping with less than thirty inches (30”) 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. The crushed gravel meeting the requirements of ASTM Designation C33, Gradation 67 (3/4 in. to No. 4). Crushed stone or pea gravel meeting the TXDOT Grade 5 gradation per test method Tex-200-F, Part I, is acceptable.

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 Technical Specification 4.28, "Sewer Line and Manhole 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

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

4.26 - Fiberglass Manholes – Type B

4.26.0 General

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 Plans 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 two inches (2") 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 two inches (2") in diameter, de-lamination and wrinkles of 1/8 inch or greater in depth. Surface pits shall be permitted up to six (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 two inches (2") 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 Technical Specification 4.26.6, "Testing". 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 the table below when tested in accordance with Technical Specification 4.26.6, "Testing."

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 (1") 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 Technical Specification 4.28, "Sewer Line and Manhole Testing".

4.26.7 Measurement and Payment

Measurement and payment for this item will be based on the lump sum price bid.

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 feet (2') 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.

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 Technical Specification 4.28 "Sewer Line and Manhole Testing," section of these contract documents.

4.27.4 Measurement and Payment

Measurement and payment for this item will be based on the lump sum price bid. Payment shall be full compensation for the furnishing of all labor, materials, tools, equipment and incidentals necessary to complete the work, including but not limited to excavation, concrete encasement, if required, disposal of excess material, backfill, embedment, concrete blocking, paving, and sod, all in accordance with the plans and specifications. There shall be no additional payment for maintaining and restoring existing service laterals.

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 sewer lines, manholes, and other appurtenances as needed for complete and proper installation as described in the plans, details, specifications and contract documents provided.

4.28.1 Testing Procedure

4.28.1.1 General

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

4.28.1.2 Pneumatic Exfiltration Test for Pipe

The Low Pressure Air Test procedure shall conform to the procedures described in ASTM C-828, ASTM C-924, ASTM F-1417 or other appropriate procedures, except for testing times. The test times shall be as outlined in this section. For sections of pipe less than thirty-six inches (36") 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 twenty-five percent (25%) of the calculated testing time. If any pressure loss or leakage has occurred during the first twenty-five percent (25%) of the testing period, then the test shall continue for the entire test duration as outlined above or until failure. Lines with a twenty-seven inch (27") average inside diameter and larger may be air tested at each joint. Pipe greater than thirty-six inches (36") in 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 ten (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 ten inches (10") 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 nine inches (9") of mercury. The manhole shall pass if the time for the vacuum reading to drop from ten inches (10") of mercury to nine inches (9") 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:

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

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

4.28.1.5 Hydrostatic Exfiltration Test for Sewer Pipes

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

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

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

4.28.1.6 Hydrostatic Test for Subaqueous Pipe Installations

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

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

Infiltration testing shall be performed in the following manner:

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

4.28.1.7 Deflection Test - Mandrel Test

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

a) The deflection test shall be run using a rigid ball or mandrel having a diameter equal to ninety-five percent (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 percent (5%).

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

No additional payment shall be made for material furnished or work done under this item, which is considered subsidiary of the various pay items.

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 the existing flow around the work area for the duration of the project.

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 he 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 Engineering Manager, Department of Water Utilities at least seven (7) 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 (3) 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. Number, size, material, location and method of installation of suction piping
6. Number, size, material, method of installation and location of installation of discharge piping
7. Bypass pump sizes, capacity, number of each size to be on site and power requirements
8. Calculations of static lift, friction losses, and flow velocity (pump curves showing pump operating range shall be submitted)
9. Standby power generator size, location
10. Downstream discharge plan
11. Method of protecting discharge manholes or structures from erosion and damage
12. Thrust and restraint block sizes and locations
13. Sections showing suction and discharge pipe depth, embedment, select fill and special backfill
14. Method of noise control for each pump and/or generator
15. Any temporary pipe supports and anchoring requirements
16. Design plans and computation for access to bypass pumping locations indicated on the Plans
17. Calculations for selection of bypass pumping pipe size
18. Schedule for installation of and maintenance of bypass pumping line.
19. Plan indicating selection of location of bypass pumping line locations
20. A control plan demonstrating the instrumentation, equipment, alarms, operations procedures, emergency procedures, reset procedures, and system wiring schematics.
21. 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 Technical Specification 4.29.4 D.2 are met.

c) The CONTRACTOR shall provide primary, backup and standby pumps as described in Technical Specification 4.29.8, "Project Specific Requirements;" section "b". 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 seventy (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 following flows:

Peak Flowrate: 0.55 MGD

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 twenty-four (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 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 twenty-four (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 twenty-four (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 Plans 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 Technical Specification 4.29.4, "Field Quality Control and Maintenance;" section "f".

4.29.8 Project Specific Requirements

a) All Pumps (Primary, Standby and Backup) required for the Bypass Pump Set shall be commonly headered on discharge and shall either be commonly headered on suction (according to provisions of Technical Specification 4.29.2, "Equipment") 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 twelve inches (12") in diameter and larger: Triple redundancy is required. System shall consist of a) primary pump(s), b) stand-by pump(s) and c) back-up pump(s).
   2. Sewer mains less than twelve inches (12") in diameter: System shall consist of a)primary pump(s) 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 two feet per second (2 fps). If multiple discharge pipe runs are utilized, at least one (1) 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 seven (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 twenty-four (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 twenty-four (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 OWNER. 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 City of San Angelo shall be notified immediately.
      ii. The "Bypass Sub-Contractor" shall have a qualified representative and mechanic on-site within twenty-four (24) hours of failure.
      iii. The Trunk Bypass System shall be returned to 100% function within seventy-two (72) hours of failure.

2. Multiple Pump (more than one) or System Failure:
    i. The CONTRACTOR, "Bypass Sub-Contractor", and City of San Angelo shall be notified immediately.
    ii. The "Bypass Sub-Contractor" shall have a qualified representative and mechanic on-site within six (6) hours of failure.
    iii. The Trunk Bypass System or System Gravity Flow shall be restored to Peak Flow Capacity within twelve (12) hours of failure.
    iv. The Trunk Bypass System shall be returned to 100% function within seventy-two (72) hours of failure.

h) 24 Hour Emergency Contacts:
1. CONTRACTOR:
    i. The CONTRACTOR shall provide a priority twenty-four (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 (1) of these individuals shall be on-site within one (1) hour of any emergency situation.
    iii. This number shall be available and responsive twenty-four (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 thirty (30) minutes.
2. "Bypass Sub-Contractor":
    i. The "Bypass Sub-Contractor" shall provide a priority twenty-four (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 twenty-four (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 thirty (30) minutes.

i) BYPASS PUMPING SCHEDULE
1. Flows shown below are based on City of San Angelo GIS Manhole IDs and modeled flows.

Sanitary Sewer Size	**Peak Wet Weather (MGD)**
8" SS	0.36
10" SS	0.31
12" SS	0.53

18” SS	2.99

2. Suggested sequence is shown below for areas that may require bypass pumping.
    i. Sanitary Sewer Laterals: For sanitary sewer laterals; A1, A2, A3, provide temporary bypass flow from existing lateral to the nearest downstream active manhole.

    ii. Proposed Sanitary Sewer Line A
        1. Install Manhole connecting to existing 24” SS Main during dry and/or low flow conditions to avoid providing bypass pumping at Station 1+00.

    iii. For Connections to existing Laterals at 5+15 provide temporary by-pass pumping from existing lateral to the nearest active downstream manhole.

4.29.9 Measurement and Payment

Measurement for this item will be based on the lump sum price bid. Payment will include full compensation for all excavation, embankment, backfilling, hauling and laying pipe, fittings, materials, testing, equipment, labor, and resources required to install and maintain a complete working installation. CONTRACTOR shall be responsible for all costs incurred by the OWNER 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 to the OWNER by 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

4.30.1 TV Wastewater Mains

a) OWNER will perform all CCTV and associated cleaning of the existing and proposed wastewater mains before and after construction.

b) Digital Video Disks (DVD) of the existing main shall be given to the engineering inspector fourteen (14) days prior to start of construction for review. DVD's of the new main shall be given to the engineering inspector fourteen (14) days after completion of the work at that location.

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

d) Measurement and payment shall be per the unit price and shall include all work necessary to TV the main and supply the DVD to the OWNER.

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

This Item will be measured by the square foot of material placed. The minimum thickness shall be six inches (6”) unless specified otherwise on the plans.

The work performed and materials furnished in accordance with this Item and measured will be paid for at the unit price bid for "Furnishing and Placing Topsoil" for the depth specified. This price shall be full compensation for securing any necessary source(s) and any royalty involved; for furnishing all materials, for all excavation, loading, hauling, stockpiling and placing; and for furnishing all labor, tools, equipment and incidentals necessary to complete the work.

"Rolling" will not be paid for directly, but will be considered subsidiary to this Item, unless otherwise shown on the plans. Payment will not be made for any material which is used for purposes other than as required by this Item.

Excavation, for topsoil, in areas upon which backfill was previously placed will neither be measured nor paid for directly; its cost will be included in the unit price bid for this Item.

There shall be no measurement for top soil as any use of top soil is for the Contractor’s benefit. Payment of top soil shall be subsidiary to drill seeding.

4.34 - Abandonment of Sanitary Sewer Mains / Services

4.34.0 General

4.34.1 Description

This item shall govern the abandonment of sanitary sewer mains/services required 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 1,000 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, they shall be a part of the abandonment project process.

4.34.4 Measurement and Payment

Grouting of abandoned sewer lines shall be measured by linear foot. Payment for abandoning sewer lines shall be made on the contract price bid complete in place. Said price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work. Unless otherwise shown on the plans, abandonment/grouting of manholes will not be a separate pay item.

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 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.

4.35.1.3 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.

4.35.1.4 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.

4.35.1.5 Steps

No steps shall be constructed in manholes.

4.35.1.6 Cleanouts

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

4.35.1.7 Concrete

Concrete shall conform to the material standards set for in Technical Specification 4.16, "Cast in Place Concrete."

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 within acceptable limits of 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 Plans, 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 two inches (2”) 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 feet (6'). 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 Technical Specification 4.25, "Closed Bottom Fiberglass Manhole – Type A".

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 Plans, for a minimum distance of two feet (2') 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 feet (2') 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 Technical Specification 4.28, "Sewer Line and Manhole Testing".

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 fifty feet (50'). 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 professional registered 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 OWNER 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.

4.44 - Concrete Curb, Elevated Concrete Curb, Gutter, 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

4.44.5.1 Measurement

Work and accepted material for concrete curb, elevated concrete curb, concrete gutter, or concrete curb and gutter will be measured by the linear foot, complete in place.

4.44.5.2 Payment

The unit prices provided shall be full compensation for all required excavation and disposal of excess material, required compaction and/or fine grading of the surface, sprinkling, materials, equipment, labor, and incidentals necessary for a complete, in-place curb, gutter, or combined curb and gutter.

4.45 - Concrete Cap and Rigid 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

All concrete shall be Class A, 3,000 psi.

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 of minimum 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 six inches (6") 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

4.45.4.1 Measurement

That portion of the work which is applicable and completed will be measured at the rate of square foot of surface area.

4.45.4.2 Payment

The unit prices bid shall be full compensation for all required excavation and disposal of sacrificial backfill and existing material required for complete construction and repair, compaction, and/or fine grading of the utility trench surface, sprinkling, materials, equipment, labor, and incidentals necessary for a complete in-place concrete cap or rigid pavement.

a) Concrete Cap Six Inch (6") Thickness: Placement of concrete cap with six inch (6") thickness where the CONTRACTOR has placed the trench backfill.

b) Rigid Pavement: Placement of rigid pavement where the CONTRACTOR has placed the trench backfill.

c) Rigid Pavement and Removal of Excess Base or Sacrificial Backfill: Placement of rigid pavement where the OWNER has placed the trench backfill.

d) Concrete Cap Six Inch (6") Thickness and Removal of Excess Base or Sacrificial Backfill: Placement of concrete cap with six inch (6") thickness where the OWNER has placed the trench backfill.

4.46 - Site Clean-up

4.46.0 General

4.46.0.1 Scope

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

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

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

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

4.46.1 Trench Spoil Removal

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

4.46.2 Measurement and Payment

4.46.2.1 Measurement

a) Hourly Site Clean-up: Prior to initiation of work on the site, the CONTRACTOR shall meet with the City of San Angelo Inspector to define the limits of site clean-up within the general area of the job site. The CONTRACTOR and the City of San Angelo Inspector shall come to a mutual agreement as to the amount of clean-up required outside the job site limits and set a reasonable time for the amount of hours required to clean-up.

b) Trench Spoil Removal: Measurement shall be for each cubic foot removed as determined by the City of San Angelo Inspector either by volume of trench work, trucked volume, or physical measurement.

4.46.2.2 Payment

a) Hourly Site Clean-up: Payment will be for all manpower, materials, equipment and resources required to clean up the site and remove all excess material and debris at the hourly rate bid in the contract for the hours determined above.

b) Trench Spoil Removal: Payment will be for the cubic feet of material removed at the unit price bid in the contract.

4.47 - Removal and Replacement of 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

The work performed and materials furnished in accordance with this Item shall be measured and paid under the Rigid Pavement bid item and shall be full compensation for furnishing all materials required; all labor, tools, equipment, all excavation and hauling of excavated material, all removal, hauling and disposal of concrete driveways, curbs, and debris and all sprinkling, compacting and incidentals necessary to complete the work.

4.49 - Tunnel Excavation and Primary Liner

4.49.0 General

4.49.0.1 Section Includes

a) Tunnel construction by placement of primary liner for installation of pipe using a primary tunnel liner with a carrier pipe. Placement of sewer pipe inside tunnel constructed with primary liner shall be in accordance with Technical Specification 4.50, "Sewer Line in Tunnels."

b) Various construction methods for tunneling, including tunnel boring machine (TBM), hand tunneling, or shield. Liners include rib and lagging, steel liner plate, bolted steel liner box, box tunnels, and segmented concrete. Liners may be expanded or grouted.

c) Install liner types as designed by CONTRACTOR's and/or "Tunneling Sub-Contractor's" Engineer according to Technical Specification 4.49.2, "Design Criteria." Use techniques and liner methods appropriate for prevailing ground conditions, unless otherwise indicated.

4.49.0.2 Reference Standards

a) American Association of State Highway and Transportation Officials (AASHTO).

b) American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering.

c) American Society for Testing Materials (ASTM)
   a. ASTM A 36 – Standard Specification for Carbon Structural Steel.
   b. ASTM A 283 – Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
   c. ASTM A 307 – Standard Specifications for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength

d) Occupational Safety and Health Administration (OSHA)

4.49.0.3 Definitions

a) Primary Liner: First tunnel support installed by Contractor in two (2) pass method.

b) Carrier Pipe: Sewer line as specified in Technical Specification 4.50, "Sewer Line in Tunnels."

c) Zone of Active Excavation: Area located within radial distance about surface point immediately above face of excavation equal to depth to bottom of excavation.

d) Critical Structure: Building, structure, bridge, pier, or similar construction partially or entirely located within zone of active excavation.

e) Tunnel Boring Machine (TBM): Mechanized and fully shielded excavating equipment that is steerable, guided and articulated, with man entry.

f) Tunneling Methodology: Written description, together with supporting documentation that defines Contractor's plans and procedures for tunneling operations.

g) Shield: Fabricated ground support, circular in section, providing 360 degree protection to those working in it. Shield will have cutting edge, and be equipped with independently operated hydraulic propulsion rams, allowing it to be steered. Liner is erected within tail attached to shield.

h) Open Face: Face of heading or tunnel which is unsupported during excavation (e.g., in hand mining or shield excavation).

i) Closed Face: Face of heading or tunnel which is supported during excavation process from TBM, where cutter head allows both partial exposure of face and full closure, by means of hydraulically operating gates.

4.49.1 Submittals

1. Tunneling Methodology: Provide a description of proposed tunnel methodology for review. Description should be sufficient to convey the following:
    a. Proposed method of tunnel construction and type of face support and lining system.
    b. Manufacturer and type of tunneling equipment proposed; type of lighting and ventilation systems.
    c. Number and duration of shifts planned to be worked each day.
    d. Sequence of operations.
    e. Location of access shafts and work sites.
    f. Method of spoil transportation from face, surface storage, and disposal location.
    g. Method of installing pipe.
    h. Identification of critical utility crossings and special precautions proposed.
    i. Manufacturer and type of chemical grout proposed.

2. Drawings and Calculations: Submit for record purposes, drawings and calculations for tunnel support system designed by CONTRACTOR and/or "Tunneling Sub-Contractor." Drawings shall be adequate for construction, and include installation details. Documents must be signed and sealed by Professional Engineer registered in State of Texas. Include calculations with clear statement of criteria used for design, as described in Specification 4.49.2, "Design Criteria."

3. Quality Control: Submit for review a description of quality control methods including but not limited to:
    a. Method and frequency of survey control.
    b. Example of tunnel daily log.
    c. Instrumentation plan showing location and frequency of monitoring relative to critical structures within zone of active excavation.
    d. Settlement survey plan (may be included instrumentation plan).

4. Geotechnical Investigation: When geotechnical investigations are conducted by CONTRACTOR and/or "Tunneling Sub-Contractor," submit results to OWNER for record purposes.

5. Monitoring Plans:
    a. Instrumentation Monitoring Plan: Submit for review, prior to construction, monitoring plan that includes schedule of instrumentation design, layout of instrumentation points, equipment installation details, manufacturer's catalog literature, and monitoring report forms.
    b. Surface Settlement Monitoring Plan: Submit settlement monitoring plan for review prior to construction. Identify location of settlement monitoring points, reference benchmarks, survey frequency and procedures, and reporting formats on plan.

6. Structures Assessment: Submit preconstruction and post-construction assessment reports for critical structures, namely those located within zone of active excavation from proposed tunnel centerline. Include photographs or video of existing damage to structures in vicinity of sewer alignment in assessment reports.

7. Submit monitor readings to OWNER.

8. Daily Reports: Maintain shift log as defined in Technical Specification 4.49.4.4, "Tunneling Data," and make available to OWNER on request.

4.49.2 Design Criteria

a) Provide primary liner designed by CONTRACTOR's and/or "Tunneling Sub-Contractor's" Professional Engineer for appropriate loading conditions and deflection criteria, including but not limited to: overburden and lateral earth pressures; handling and installation stresses; loads imposed by tunnel shield or tunnel boring machine thrust jacks; subsurface soils and water loads: grouting; and other conditions of service. Assume responsibility for design of primary liner to carry construction loads in combination with overburden, earth and hydrostatic loads.

b) For truck loading use HS-20 vehicle loading distributions in accordance with AASHTO.

4.49.3 Products

4.49.3.1 Steel Liner Plates

a) In locations shown on Plans, manufacture liner plate (2-flange or 4-flange) certified by manufacturer for compliance with Specifications.

b) Provide bolts and nuts conforming to ASTM A 307, Grade A.

c) Punch plates for bolting on both longitudinal and circumferential seams and fabricate to permit complete erection from inside tunnel. Provide plates of uniform fabrication. Plates intended for one size tunnel shall be interchangeable.

d) Material used for construction of liner plates shall be in good condition.

e) Provide sufficient number of bolted steel liner plates with approximately two inch (2") diameter grout holes furnished with plugs. Locate holes near plate center.

4.49.4 Execution

4.49.4.1 Preparation

a) Use methods for tunneling operations that will minimize ground settlement. Select method which will control flow of water, prevent loss of soil into tunnel, and provide stability of face under anticipated conditions.

b) Conduct tunneling operations in accordance with applicable safety rules and regulations, OSHA standards, and CONTRACTOR's and/or "Tunneling Sub-Contractor's" safety plan. Use methods which include due regard for safety of workmen, adjacent structures, utilities, and public.

c) Maintain clean working conditions inside tunnel and shafts.

d) For tunneling under railroads embankments, highways, or streets, perform installation so as to avoid interference with operation of railroads, highways, or streets, except as approved by owner of facility.

e) Support ground continuously in manner to prevent loss of ground and keep perimeters and faces of tunnel stable.

f) Completed primary tunnel lining shall have full bearing against ground. Grout peripheral space between support elements and excavated surface or close by expanding support elements against ground to achieve full bearing as tunnel advances.

g) Ground Conditions: Perform additional exploration by geotechnical borings in advance of construction to define necessary parameters for design of primary tunnel liner, planning and designing ground water control system, and for selection of tunneling method and equipment to successfully complete each tunnel reach.

h) Be aware that various existing soil borings, piezometers, or instrument wells, where indicated on the Plans, may coincide with proposed tunnel alignment. These may or may not have been backfilled with grout, and therefore, caution should be used in tunneling through these locations. Contractor shall take mitigating measures to counter effect these boreholes, piezometer, or instrument wells may have on tunneling operations.

4.49.4.2 Ground Water Control

a) Provide necessary ground water control measures to perform work and to provide safe working conditions.

b) Anticipate that portions of tunnel excavation may be below ground water table and in cohesionless soils, even when not indicated on soil borings, and in conditions which may require ground water control system for tunneling operations. Install filter fabrics, backer rods and other means as necessary to prevent piping of fines into tunnel.

c) When CONTRACTOR and/or "Tunneling Sub-Contractor" chooses pumping installation to control ground water level or installs pervious liner through water bearing layers, install and maintain instrumentation system to monitor water level and to detect movement in adjacent

structures and property.

d) Operate dewatering system for tunnels until carrier pipe has been installed and annular space is fully grouted, or until watertight liner designed for hydrostatic pressures is installed.

e) Do not proceed with tunneling for which ground water control is necessary until monitoring data indicated that ground water control system is operating in accordance with CONTRACTOR's and/or "Tunneling Sub-Contractor's" plan.

4.49.4.3 Equipment

a) Assume responsibility for selection of tunneling equipment which, based on past experience, has proven to be satisfactory for excavation of soils to be encountered.

b) Employ tunneling equipment that will be capable of handling various anticipated ground conditions and which minimize loss of soil ahead of face and allows satisfactory support of excavated face.

c) TBM or shield shall conform to shape of tunnel with uniform perimeter that is free of projections that could produce over excavation or voids. An appropriately sized over cutting bead may be provided to facilitate steering. In addition it shall:
    1. Be capable of full directional guidance.
    2. Be capable of full face closure, or permit ready installation of breasting boards.
    3. Be equipped with appropriate tail in which liner is erected.
    4. Be capable of correcting roll.
    5. Be designed to handle adverse ground conditions including ground water ingress.
    6. Be equipped with visual display to show operator actual position of TBM or shield relative to design reference.

d) Air Quality: Provide equipment to maintain proper air quality of tunnel operations during construction in accordance with OSHA requirements.

e) Enclose light fixtures in watertight enclosures with suitable guards. Provide separate circuits for lighting and other equipment.

f) Conform to requirements of National Electrical Code – NFPA70 for Electrical systems.

4.49.4.4 Tunneling Data

a) Maintain shift logs of construction events and observations. OWNER shall have access to CONTRACTOR's and/or "Tunneling Sub-Contractor's" logs with regard to the following information:
    1. Location of face by station and progress of tunnel drive during shift.
    2. Hours worked per shift on tunneling operations.
    3. Completed field forms for checking line and grade of tunneling operation, showing achieved tolerance relative to design alignment. Steering control logs will generally be acceptable for shield or TBM driven tunnels.
    4. Location, elevation and brief soil description of soil strata and strata boundaries.
    5. Ground water control operations and piezometric levels, ground water inflow

location and rates.
6. Observation of lost ground or other ground movement.
7. Unusual conditions or events.
8. Reasons for operational shutdown in event drive are halted.

b) Clearly mark primary liner with paint every twenty feet (20') along tunnel with distance in feet from centerline of preceding shaft.

4.49.4.5 Tunnel Excavation and Primary Liner Installation

a) Tunnel Excavation
    1. Conduct tunneling operations in accordance with applicable safety rules and regulations, and CONTRACTOR's and/or "Tunneling Sub-Contractor's" safety plan. Use method which include due regard for safety of workmen, adjacent structures, utilities, and public.
    2. Maintain tunnel excavation within easements and rights-of-way indicated on the Plans, to lines and grades shown on the Plans. Excavation shall be of sufficient size to allow installation of sewer pipe to lines and grades indicated on the Plans.
    3. Open-face Excavations:
        i. Keep face breasted or otherwise supported and prevent falls, excessive raveling, or erosion. Maintain standby face supports for immediate use when needed.
        ii. During shut-down periods, support face of excavation by positive means; do not rely solely on hydraulic pressure for support.
    4. Closed-face Excavation:
        i. Control volume of spoil removed. Determine that advance rate and excavation rate are compatible to avoid over excavation or loss of ground.
        ii. When cutting head is withdrawn, keep excavated face supported and stabilized.
        iii. When face of machine is open for maintenance, monitor conditions that might threaten stability of heading. Take appropriate action to prevent or limit influx of soils and water which would threaten stability of heading.
    5. Whenever condition is identified which could endanger tunnel excavation or adjacent structures, operate continually for twenty-four (24) hours day, including weekends and holidays, without intermission until condition no longer exists.

b) Determination of primary liner size and section shall be sole responsibility of the CONTRACTOR's and/or "Tunneling Sub-Contractor's" Engineer, to match construction methods and equipment described in tunneling methodology submittal. Provide tunnels of sufficient size to permit efficient excavation operations, sufficient working space for placing primary tunnel liner, and to allow for installation of sewer pipe.

c) Primary Liner Installation:
    1. Provide method to ensure full bearing of soil against primary liner without significant settlement or movement of surrounding soil. To fill void behind primary liner, either expandable liner (e.g., ring beams and timber lagging) or non-expandable liner (e.g., bolted steel liner plates) may be used provided grout is placed behind non-expandable liner. Box tunnel where ground is excavated to true shape may be un-grouted.

2. When using TBM or tunnel shield, advance equipment only far enough to permit construction of one primary liner set, entirely within equipment shield.
3. Install filter fabric around exterior of primary liner when using steel ribs and lagging. Install backer rods at ribs as required to control migration of fines. Close windows in lagging.
4. After grouting, ensure deflection of liner is no more than allowable, nor liner is distorted by excessive pressure.

d) Seal blind headings with temporary bulkhead.

e) Grouting: Requirements pertaining to grout mix design and tunnel grouting are provided in Technical Specification 4.51, "Tunnel Grout."

4.49.4.6 Control of Tunnel Line and Grade

a) Construction Control:
   1. OWNER may require for Surveyors to use the OWNER's Continually Operating Reference Station (CORS) for horizontal control.
   2. OWNER will establish benchmarks indicated on the Plans. Check benchmarks at beginning of Work and report errors or discrepancies to OWNER.
   3. Use benchmarks established by OWNER to establish and maintain construction control points, reference lines, and grades for locating tunnel.
   4. Establish control points sufficiently far from face so as not to be affected by tunneling operations.

b) Benchmark Movement: Ensure that when settlement of ground surface occurs during construction which affects accuracy of temporary benchmarks, detect and report such movement and reestablish temporary benchmarks. Locations of permanent City of San Angelo monumentation benchmarks are indicated on the Plans. Advise OWNER of settlement affecting permanent monumentation benchmarks. Upon completion, submit field book pertaining to monitoring of permanent monumentation benchmarks to OWNER.

c) Line and Grade:
   1. Maintain means sufficient to check alignment and grade continuously.
   2. Check survey control for tunneling against aboveground undisturbed reference at least once each week and once for each twenty-five feet (25') of tunnel constructed.
   3. When excavation is off line or grade, make alignment corrections to avoid reverse grades in gravity sewers.
   4. Construct primary liner to such tolerances that permit installation of sewer pipe to be completed to tolerances given in Section 4.50, "Sanitary Sewer Line in Tunnels."

d) Earth Movement: Assume responsibility for damage due to settlement from construction-induced activities or occurrences.
   1. Survey crown, invert, and springline on each side of primary liner at twenty-five foot (25') intervals or minimum of once per shift or more frequently when line and grade tolerances have been exceeded, to ensure alignment is within tolerances specified. Conduct survey immediately behind tunnel excavation to all immediate correction of misalignment.

4.49.4.7 Monitoring

a) Instrumentation Monitoring: Instrumentation requirements shall be according to the "Vibration Monitoring Specialist" in accordance with Technical Specification 4.43, "Vibration Monitoring." Ensure instrumentation specified is accessible to OWNER. Submit readings promptly to OWNER.
    1. Install and maintain instrumentation system to monitor and detect movement of ground surface and adjacent structures. Establish vertical control point at distance from construction areas that avoids disturbance due to ground settlement.
    2. Installation of instrumentation shall not preclude OWNER, through independent contractor or consultant, from installation instrumentation in, on, near, or adjacent to construction work. Provide access to work for such independent installations.

b) Surface Settlement Monitoring
    1. Establish monitoring points on all critical structures.
    2. Record location of settlement monitoring points with respect to construction baselines and elevations. Record elevations to accuracy of 0.01 feet for each monitoring point location. Monitoring points should be established at locations and by methods that protect them from damage by construction operations, tampering, and other external influences.
    3. Ground surface elevations must be recorded on centerline ahead of tunneling operations at minimum of fifty foot (50') intervals or at least three (3) locations per tunnel drive. For primary lined tunnels greater than sixty inches (60") cut diameter also record similar data at approximately twenty feet (20') each side of centerline. Clearly mark settlement monitoring points by studs or paint for ease of locating.
    4. Railroads: Monitor ground settlement of track sub-base at centerline of each track.
    5. Utilities and Pipelines: Monitor ground settlement directly above and ten feet (10') before and after utility or pipeline intersection.

c) Reading Frequency and Reporting: Submit to OWNER, records of reading from various instruments and survey points.
    1. Instrumentation monitoring results to be read at frequency specified, unless otherwise specified. Start monitoring before zone of active excavation is passed and until no further detectable movement occurs.
    2. Record surface settlement monitoring readings:
        i. Prior to zone of active excavation reaching that point.
        ii. When tunnel face reaches monitoring point (in plant), and
        iii. When zone of active excavation has passed and no further movement is detected.
    3. Submit monitoring readings promptly to OWNER.
    4. Immediately report to OWNER movement, cracking, or settlement which is detected.
    5. Following substantial completion but prior to final completion, perform final survey of monitoring points.

4.49.4.8 Disposal of Excess Material

a) Remove spoil from job site and dispose in accordance with Technical Specification 4.3.18, "Disposal of Excess Excavated Materials."

4.49.5 Measurement and Payment

a) Unit Prices:
    1. Work performed under this Section such as excavation, primary liner, and grouting will not be paid directly. Include cost of this work in unit prices for installation of sewer line in tunnel, in accordance with Technical Specification 4.50, “Sanitary Sewer Line in Tunnels.”
    2. Monitoring will be paid for at a lump sum price for installation, observation, and reporting.

b) Stipulated Price (Lump Sum): If contract is Stipulated Price Contract, payment for work in the Section is included in Total Stipulated Price.

4.50 - Sewer Line in Tunnels

4.50.0 General

4.50.0.1 Section Includes

a) Handling, transporting, and installing sanitary and storm sewer lines in primary lined tunnels.

4.50.1 Submittals

a) Provide a description of method of transporting carrier pipe into tunnel; method of hoisting and positioning pipe; method of jointing and aligning pipe; and blocking plan.

b) Submit buoyant force calculations, bulkhead design, and blocking details. Include in calculations analysis of stresses and deformation induced on carrier pipe. Submittal must be signed and sealed by Professional Engineer registered in State of Texas.

4.50.2 Products

4.50.2.1 Pipe Material and Fittings

a) Sewer pipe may consist of fiberglass pipe (FRP), polyvinyl chloride (PVC) pipe, high density polyethylene (HDPE) pipe, or combinations of these. Storm sewers do not require lining.

b) Install pipe type as shown on the Plans. Assume responsibility for pipes and pipe joints to safely carry loads imposed during construction.

4.50.2.2 Fiberglass Pipe

a) Provide fiberglass pipe, joints, and fittings in accordance with Technical Specification 4.22, "Glass-Fiber-Reinforced Thermosetting-Resin Gravity Sewer Pipe."

4.50.2.3 Polyvinyl Chloride Pipe

a) Provide polyvinyl chloride pipe, joints and fittings in accordance with Technical Specification 4.23, "Polyvinyl Chloride (PVC) Gravity Sewer Pipe."

4.50.2.4 High Density Polyethylene Pipe

a) Provide High Density Polyethylene (HDPE) Solid and Profile Wall Pipe, joints and fittings in accordance with Technical Specification 4.21, "High Density Polyethylene (HDPE) Gravity Sewer Pipe."

4.50.2.5 Annular Grout

a) Provide for grouting of annular space between pipe and tunnel liner as specified in Technical Specification 4.51, "Tunnel Grout."

4.50.3 Execution

4.50.3.1 Installation Tolerances

a) Prior to installing sewer pipe, verify that primary liner has been constructed so that sewer

pipe may be placed in conformance with specified tolerances.

b) Tolerances from lines and grades shown on the Plans for sewer pipe installed in primary liner are plus or minus six inches (6") in horizontal alignment and plus or minus 1-1/2 inches in elevation. Should misalignment of primary liner preclude installation of sewer pipe to tolerances specified, notify OWNER.

4.50.3.2 Pipe Handling

a) Handle and transport pipe into tunnel in manner that prevents damage to pipe, joints, gaskets, and plastic liner. Do not install pipe damaged during placement operations. Propose repair procedures for review and approval of OWNER.

4.50.3.3 Tunnel Cleanup

a) Prior to pipe placement in tunnel, remove temporary tunnel utilities, such as electrical and ventilation. Remove loose material, dirt, standing water, and debris prior to pipe placement.

b) Temporary steel construction tracks or steel pipe skids may be left in place when they do not interfere with alignment of sewer pipe or interfere with final placement of annular group.

4.50.3.4 Invert Pipe Support

a) Provide support adequate to establish final pipe grade. Support may include screeded concrete, steel beam, or other method as designated by CONTRACTOR's and/or "Tunneling Sub-Contractor's" Engineer. Secure pipe support to pipe or primary liner. When concrete is used for pipe support, cure it minimum of twelve (12) hours prior to setting pipe.

4.50.3.5 Joining Pipe in Tunnels

a) Join pipe segments to properly compress gaskets and allow for correct final positioning of pipe for line and grade. Closely align pipe by bringing them loosely together by means of hydraulic jacks, locomotives, pipemobiles, or winches. Once pipes have been loosely joined, pull them home by means of hydraulic tugger or another similar method suitably protecting pipe and joints against damage. Impact jointing such as ramming with locomotives or other mechanical equipment is not permitted.

4.50.3.6 Blocking Pipe in Tunnel and Bulkheads

a) Install pipe blocking system. Use pipe blocking to position sewer pipe in tunnel to allow minimum of four inches (4") of grout to be placed between sewer pipe and tunnel primary liner or casing.

b) Secure blocking rigidly in place without dependence on wedges to prevent dislodging during pipe placement and grouting operations.

c) Construction bulkheads to withstand imposed grout pressure without leakage. Provide adequate venting for bulkheads.

4.50.3.7 Acceptance Testing

a) Perform as-built survey on installed sewer pipe. Take invert elevations at each pipe joint. Take two diameter readings, at right angles, randomly at average of twenty feet (20') spacing or less in non-rigid pipe.

b) Test for leakage by low pressure air methods in accordance with Technical Specification 4.28, "Sewer Line and Manhole Testing."

4.50.4 Measurement and Payment

a) Unit Prices.
    1. Length of sewer installed in primary lined tunnels will be measured by linear foot along center line of completed sewer, center line to center line of manholes, as designated on the Plans, and to end of stubs or termination of pipe; and to inside face of lift stations and treatment plant works. Installation of sewer within limits of structure other than manholes will not be considered for measurement and payment at unit price bid.
    2. Payment for installation of sewer in primary lined tunnels is on a linear foot basis.

b) Stipulated Price (Lump Sum): If Contract is a Stipulated Price Contract, payment for work in this Section is included in Total Stipulated Price.

4.51 - Tunnel Grout

4.51.0 General

4.51.0.1 Section Includes

a) Mix design requirements, testing, furnishing and production of grout for:
   1. Pressure grouting of bolted liner plates for shafts
   2. Pressure grouting of primary tunnel liner
   3. Pressure grouting of jacked-pipe
   4. Annular grouting of cased or uncased sewer pipe
   5. Grouting of annular space between carrier pipe and primary tunnel liner
   6. Grouting voids in ground resulting from caving, loss of ground, or settlement
   7. Grouting of manholes constructed in shafts

b) Compaction grouting is not part of this specification.

4.51.0.2 Definitions

a) Pressure Grouting: Filling void behind liner or pipe with grout under pressure sufficient to ensure void is properly filled but without overstressing temporary or permanent ground support, or causing ground heave to occur.

b) Back Grouting: Secondary pressure grouting to ensure that voids have been filled between primary tunnel or shaft liners and surrounding ground.

c) Annular Grouting: Filling annular space between carrier pipe and primary tunnel liner, casing, or ground, by pumping.

d) Ground Stabilization Grouting: Filling of voids, fissures, or under-slab settlement due to caving or loss of ground by injecting grout under gravity or pressure to fill void.

e) Carrier Pipe: Sanitary or storm sewer or water line installed inside primary tunnel support.

4.51.0.3 Reference Standards

a) ASTM C 138. Standard Test Method for Unit Weight, Yield and Air Content (Gravimetric) of Concrete.

b) ASTM C 144. Standard Specification for Aggregate for Masonry Mortar.

c) ASTM C 150. Standard Specification for Portland Cement.

d) ASTM C 494. Standard Specification for Chemical Admixture for Concrete.

e) ASTM C 618. Standard Specification for Coal Fly Ash and Raw or Calcinated Natural Pozzolan for use as Mineral Admixture in Portland Cement Concrete.

f) ASTM C 869. Standard Specification for Foaming Agents Used in Making Preformed

Foam for Cellular Concrete.

g) ASTM C 937. Standard Specification for Grout Fluidifier for Pre-placed Aggregate Concrete.

h) ASTM C 942. Standard Test Method for Compressive Strength of Grout for Pre-placed Aggregate Concrete into Laboratory.

i) ASTM C 1017. Standard Specification for Chemical Admixture for Use in Producing Flowing Concrete.

4.51.1 Submittals

a) Submit description of materials, grout mix, equipment and operational procedures to accomplish each grouting operation. Description may include sketches as appropriate, indicating type and location of mixing equipment, pumps, injection points, venting method, flow lines, pressure measurement, volume measurement, grouting sequence, schedule, and stage volumes. Tests and certifications shall have been performed within last twelve (12) months prior to date of submittal.

b) Submit grout mix design report, including:
   1. Grout type and designation
   2. Grout mix constituents and proportions, including materials by weight and volume
   3. Grout densities and viscosities, including wet density at point of placement
   4. Initial set time of grout
   5. Bleeding, shrinkage/expansion
   6. Compressive strength
   7. Detailed description of grout pressure limiting equipment
   8. For annular space grouting, buoyant force calculations and bulkhead designs

c) For cellular grout, also submit the following:
   1. Foam concentrate supplier's certification of dilution ratio for foam concentrate.
   2. A description of proposed cellular grout production procedures.

d) Maintain and submit logs of grouting operations indicating pressure, density, and volume for each grout placement.

4.51.2 Products

4.51.2.1 Materials

a) Grouting materials: Conform to Technical Specification 4.16, "Cast in Place Concrete," except as modified in the following paragraphs.

b) Grout Type Applications:
   1. Grout for pressure grouting, backfill grouting and annular grouting: Sand-cement mortar mix.
   2. Grout for annular grouting of sanitary sewer: Low density (cellular) grout, unless otherwise approved by OWNER.
   3. Grout for filling space around manholes in shafts: Sand-cement mortar mix.

4. Ground stabilization: Sand-cement mortar mix.

c) Do not include toxic or poisonous substances in grout mix or otherwise inject such substances underground.

4.51.2.2 Grout

a) Employ and pay for commercial testing laboratory, acceptable to OWNER, to prepare and test grout mix design. Develop one or more mixes based on following criteria as applicable:
   1. Size of annular void between sewer pipe and liner, or size of void between primary liner and surrounding soil
   2. Absence or presence of groundwater
   3. Adequate retardation
   4. Non-shrink characteristics
   5. Pumping distances

b) Prepare mixes that satisfy required application. Provide materials conforming to the following standards:
   1. Cement: ASTM C 150
   2. Fly Ash: ASTM C 618
   3. Water: Potable
   4. Foam: ASTM C 869
   5. Slurry: ASTM C 138
   6. Cellular Grout: ASTM C 138
   7. Sand for sand-cement mortar mix: ASTM C 144

c) Provide grout meeting the following minimum requirements:
   1. Minimum twenty-eight (28) day unconfined compressive strength: 1,500 psi for water lines, 1,000 psi for other carrier pipes for mortar grout and 300 psi for cellular grout.
   2. Determine strength by ASTM C 942.
   3. Maximum allowable density: Less than 130 pcf

d) Fluidifier: Provide fluidifier, meeting ASTM C 937 that holds solid constituents of grout in colloidal suspension and is compatible with cement and water used in grouting operations.

e) Admixtures:
   1. Use admixtures meeting ASTM C 494 and ASTM C 1017 as required, to improve pump ability, control time of set, hold sand in suspension and reduce segregation and bleeding.
   2. For cellular grout, do not use foam or admixtures that promote steel corrosion.
   3. Ensure that admixtures used in mix are compatible. Provide written confirmation from admixture manufacturers of their compatibility.

4.51.3 Execution

4.51.3.1 Preparation

a) Notify OWNER at least twenty-four (24) hours in advance of grouting operations.

b) Select and operate grouting equipment to avoid damage to new or existing underground utilities and structures.

c) In selection of grouting placement consider pipe flotation, length of pipe, length of tunnel, depth from surface, and type of sewer pipe, type of pipe blocking and bulkheading, grout volume and length of pipe to be grouted between bulkheads.

d) Operate dewatering systems until grouting operations are complete and grout has reached initial set.

4.51.3.2 Equipment

a) Batch and mix grout in equipment of sufficient size and capacity to provide necessary quality and quantity of grout for each placement stage.

b) Use equipment for grouting of type and size generally used for work, capable of mixing grout to homogeneous consistency, and providing means of accurately measuring grout component quantities and accurately measuring pumping pressures. Use pressure grout equipment which delivers grout to injection point at steady pressure.

4.51.3.3 Pressure Grouting For Primary Tunnel and Shaft Liner

a) Perform grouting operations to fill voids outside of primary tunnel or shaft liner.

b) For nonexpendable primary liners installed behind shield or tunnel boring machine (TBM) fill voids with sand-cement grout promptly after each ring of liner is out of shield. Keep grout pressure below value that may cause damage or distortion to installed liner plate rings. Provide seals on tail of shield or TBM which will prevent grout from spilling.

c) For nonexpendable primary liners installed by hand mining or in shafts, grout once every four feet (4') or more frequently when conditions dictate.

d) Control grout pressures so that tunnel or shaft liner is not overstressed, and ground heave is avoided.

e) For liner requiring grout, perform back grouting once each shift, or more often when required to ensure that all voids are filled.

4.51.3.4 Annular Grouting For Sewer Line in Tunnels and In Cased or Uncased Augers

a) Fill annular space between sewer pipe and tunnel primary liner, casing or ground, with grout.

b) Placement

1. Placement Limits: Predetermine limits of each grout placement stage by size and capacity of batching equipment and initial set time of proposed grout. Under no circumstances shall placement continue at grout port longer than that period of time for mix to take initial set. Locate grout hole spacing and locations according to number of stages necessary to grout tunnel liners. Stage or lift cannot be installed on another lift until proper set has been attained. Have placement procedures approved by admixture or additive manufacturer.

2. Limit pressure on annular space to prevent damage or distortion to pipe or liner. Define limiting and estimated required pressure range. Provide an open ended, high point tape or equivalent vent and monitor it at bulkhead opposite to point of grouting.
3. Pump grout until material discharging is similar in consistency to that at point of injection.
4. In primary lined tunnel, limit length of pipe installed to 200 feet or less before grouting same length of sewer line. Repeat this cycle until all pipe is installed and grouted.

c) Remove temporary bulkheads installed for grouting.

d) Batch and mix cellular grout mechanically to ensure consistency of mix. Wet solids thoroughly before introduction of foaming agent. Operate batching system to maintain slurry weight within three percent (3%) of design density. Introduce foam into slurry in accordance with manufacturer's recommendations.

4.51.3.5 Pressure Grouting For Jacked Pipe

a) For jacked pipe sixty inches (60") in diameter or greater, pressure grout annulus after installation, displacing bentonite lubrication. Jacked pipes less than sixty inch (60") diameter may be left ungrouted unless excavated diameter exceeds external pipe diameter by more than one inch.

b) Inject grout through grout holes in sewer pipe. Drilling holes from surface or through carrier pipe walls is not allowed. Perform grouting by injection it at pipe invert with bentonite displacement occurring through high point tap or vent.

c) Control ground water as necessary to permit completion of grouting without separation of grout materials.

d) Limit pressures to prevent damage or distortion to pipe or to keep flexible pipe within acceptable tolerances.

e) Pump grout until material discharging is similar in consistency to that at point of injection.

4.51.3.6 Field Quality Control

a) Pressure Grouting for Primary Tunnel and Shaft Liners.
    1. For each shaft, make one (1) set of four (4) compressive test specimens for each thirty foot (30') depth and one (1) set for remaining portion less than thirty foot (30') increment.
    2. Make one set of four compressive test specimens for every 200 feet of primary lined, (non-expandable) tunnel requiring grout.

b) Annular Grouting for Sewer Line in Tunnels and in Cased or Uncased Augers.
    1. Make one (1) set of four (4) compressive test specimens for every 200 feet of sewer pipe installed in primary lined tunnel.
    2. For cased or uncased augers, make one (1) set of four (4) compressive test specimens for each grouting operation, or for each 100 feet of pipe installed,

whichever is more frequent.

3. For cellular group, check slurry density both at point of batching and placement at least twice each hour in accordance with ASTM C 138. Record density, time, and temperature. Density must be within 3 percent of design density at point of batching and five percent (5%) of design density at point of placement.

c) Pressure Grouting for Jacked Pipe. Make one set of four compressive test specimens for every 400 feet of jacked pipe pressure grouting.

d) Ground Stabilization Grouting. Make one set of four compressive test specimens for every location where ground stabilization grouting is performed.

4.51.4 Measurement and Payment

a) Unit Prices.

1. No separate payment will be made for work performed under this Section. Include cost of such work in contract unit prices for work of which it is component part.

b) Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

4.52 - Tunnel Shafts

4.52.0 General

4.52.0.1 Section Includes

a) Construction, maintenance, and backfilling requirements of tunnel shafts.

4.52.0.2 Submittals

a) Shaft design submittals by CONTRACTOR and/or "Tunneling Sub-Contractor" shall be signed and sealed by Professional Engineer registered in State of Texas. If trench box is used in tunnel shaft and such utilization is in a manner other than what is indicated and certified in manufacturer's technical data, submit trench box manufacturer certification of proposed usage.

b) Submit shaft construction drawings and seal slabs. Clearly indicate allowable surcharge loads and restrictions on surcharge capacity, including live loads, on shaft construction drawings. Indicate thrust blocks or other reactions required for pipe jacking, when applicable.
    1. Location of shafts by station and limits of working sites.
    2. Description of site security arrangements in conformance with Paragraph 3.03, Shaft Construction.
    3. Description of method of extending shaft above flood level in conformance with Technical Specification 4.51.1.3, "Shaft Construction."
    4. Any geotechnical / boring undertaken by CONTRACTOR and/or "Tunneling Sub-Contractor" for whatever purpose connected to Work.

c) Shaft Monitoring Plan: Submit for review prior to construction, shaft monitoring plan that includes schedule of instrumentation design, layout of instrumentation parts, equipment installation details, manufacturer's catalog literature, and monitoring report forms.

d) Structures Assessment: Provide preconstruction and post-construction assessment reports for critical structures located within radius of shaft center equal to shaft depth plus shaft radius, measured in plan. Include photographs or video of any existing damage to structures in vicinity of shafts in assessment reports.

e) Submit shaft surface settlement monitoring plan for review prior to construction. Identify location of settlement monitoring points, reference benchmarks, survey frequency and procedures, and reporting formats on plan.

f) Submit readings of monitoring plans to OWNER as soon as readings have been taken.

g) Submit shaft temporary deck drawings and calculations to OWNER, signed and sealed by CONTRACTOR's and/or "Tunneling Sub-Contractor's" Professional Engineer in event that shaft is not needed for immediate construction activity, in conformance with Technical Specification 4.51.1.3, "Shaft Construction."

4.52.0.3 Performance Requirements

a) Shaft design must include allowance for contractor's equipment and stored material and spoil stockpile as appropriate. Design must also allow for HS-20 highway loading if located in the vicinity of a paved area.

b) Design shaft to withstand full hydrostatic head without failure.

c) Design shaft located within 50-year flood plan with water retaining liner extending 2 feet above 50-year flood elevation. It is acceptable when liner is stored at site for immediate installation in lieu of it being installed at shaft, provided that shaft liner extends at least 2 feet above existing ground elevation.

d) Design shaft cover for minimum 25 pounds per square foot distributed load plus 300-pound point load.

e) Design steel plate deck, if such as required, for HS-20 loading.

4.52.1 Execution

4.52.1.1 Location of Access Shafts

a) Contractor has sole responsibility for selection of shaft sites needed for construction operations unless otherwise indicated on the Plans. Location will be subject to the approval of the OWNER.

b) Locate shafts and associated work areas to avoid blocking driveways and cross streets, and to minimize disruption to business and commercial interests. Avoid shaft locations near areas identified as residential or potentially contaminated.

c) Plan shaft locations to minimize interference with storm drainage channels, ditches, water lines, sanitary sewers, storm water sewers or culverts, which, when damaged, could result in ground washout or flooding of shafts and tunnels.

4.52.1.2 Utility Relocation

a) Relocate utilities as shown on the Plans. Utility relocations required by "Tunneling Sub-Contractor" for shaft construction shall take into account zone of potential settlement in vicinity of shaft.

b) Obtain approval from OWNER for permanent relocations prior to relocating.

4.52.1.3 Shaft Construction

a) Conform to the following for ground support systems:
    1. Install liner elements, bracing and shoring structural members at locations and in method sequence and tolerances defined on shaft construction drawings as excavation progresses.
    2. Ensure bracing and shoring are in contact with liner to provide full support as shown in shaft construction drawings. Evaluate and check modifications to liner, bracing and shoring. Obtain approval from CONTRACTOR's and/or "Tunneling Sub-Contractor's" Professional Engineer and submit to OWNER.

3. Install seal slab as soon as final depth and stable bottom conditions have been reached and accepted by OWNER. Construct seal slab capable of withstanding full piezometric pressure, either by pressure relief using under drains, or in case of more permeable ground condition, by use of structural reinforced slab. Construct seal slab in accordance with design provided by CONTRACTOR's and/or "Tunneling Sub-Contractor's" Professional Engineer.
4. Design and construct entire shaft to appropriate factors of safety against yield, deformation, or instability as determined by CONTRACTOR's and/or "Tunneling Sub-Contractor's" Professional Engineer. Shaft must withstand full hydrostatic head without failure.
5. Special framing, bracing or shoring required around tunnel "eyes" or other penetrations shall be in-place according to shaft construction drawings before liner or any bracing or shoring at penetration is cut or removed.
6. Securely breast and shore face of starter or back tunnels to resist both soil and hydrostatic pressure.
7. When applicable, pressure grout voids or seepage paths around shafts and adjoining tunnels in accordance with Technical Specification 4.51, "Tunnel Grout. Pressure grout bolted steel liner plates as they are installed, unless otherwise approved by OWNER. Perform secondary or 'back grouting' as ground measurement, voids or deformation of shaft liner are detected.

b) Install suitable thrust or reaction blocks as required for pipe jacking equipment.

c) Provide drainage from shafts while work is in progress and until adjacent pipe joints have been sealed and shaft is backfilled. Conform to requirements of Technical Specification 4.3.5, "Dewatering".

d) Surface Water Control: Divert water runoff and discharge from dewatering system away from shaft. Protect shafts from infiltration or flooding.

e) Each surface work site is to be surrounded by security fence, which shall be secure any time site is unattended by Contractor's personnel.

f) Protect shaft, when not in use by second security fence at perimeter of shaft, or alternatively by cover designed in accordance with Technical Specification 4.5.0.3, "Performance Requirements."

g) Provide portable concrete traffic barriers at locations where work site is situated adjacent to highway, road, driveway, or parking lot. Angle traffic barriers in direction of lane flow. Do not place perpendicular to on-coming traffic.

h) Provide and maintain traffic control system in accordance with provision of Technical Specification 4.2.6, "Maintenance of Traffic".

i) Cover shaft which is constructed more than 60 days in advance of its intended use by steel plate deck designed by CONTRACTOR's and/or "Tunneling Sub-Contractor's" Professional Engineer, and restore surface to permit full traffic flow during time shaft is not in use. Remove from site other material and equipment used by CONTRACTOR and/or

"Tunneling Sub-Contractor" including portable concrete traffic barriers, traffic control system, fencing and reinstall at time shaft is re-opened for use.

j) Construct suitable guardrail barrier around periphery of shaft, meeting applicable safety standards. Properly maintain barrier throughout period shaft remains open. Repair broken boards, supports and structural members. Provide ladder with safety cage, when required by OSHA, in each shaft. Provide security barrier for each access shaft in which there is no construction activity or which is unattended by CONTRACTOR and/or "Tunneling Sub-Contractor" personnel.

k) Size of Shafts: Make size adequate for construction of permanent structures indicated on the Plans and to provide adequate room to meet operational requirements for tunnel construction and backfill.

4.52.1.4 Backfill

a) Provide cement-stabilized sand to minimum depth of ten feet (10') above crown of sanitary sewer, but where shaft is located in paved area, cement-stabilized sand shall be used to within one foot of pavement subgrade elevation. Provide cement-stabilized sand in accordance with TCEQ Chapter 217. Compacted cement-stabilized sand may be backfilled with select backfill in accordance with Technical Specification 4.3, "Excavation and Backfill". When insufficient work space exists, Grout manhole or structure annular space in accordance with Technical Specification 4.51, "Tunnel Grout."

b) Remove shaft liner above level of eight feet (8') below ground surface, unless otherwise indicated on the Plans. Maintain sufficient ground support to meet excavation safety requirements while removing shaft structure.

4.52.1.5 Monitoring

a) Monitoring Instrumentation. Instrumentation specified and readings shall be accessible at all times to OWNER.
    1. Install and maintain instrumentation system to monitor and detect movement of ground surface and adjacent structures. Establish vertical survey control points at distance from construction area that avoids disturbance due to ground settlement.
    2. OWNER may through independent contractor or consultant, from installing instrumentation in, on, near, or adjacent to construction work. Provide access to work for such independent installations.
    3. Install instruments in accordance with the Plans and manufacturer's recommendations.

b) Surface Settlement Monitoring
    1. Establish monitoring points on all critical structures.
    2. Record location of settlement monitoring points with respect to construction baselines and elevations. Record elevations to an accuracy of 0.01 feet for each monitoring point location. Establish monitoring points at locations and by methods that protect them from damage by construction operations, tampering, or other external influences.
    3. Monitoring points to measure ground elevation are required at distance of ten feet (10') and twenty feet (20') from perimeter of shaft on each of four radial lines, at

ninety degrees (90°) to each other.

4. Railroads: Monitor ground settlement of track subbase at centerline of each track when within zone of potential settlement.

c) Reading Frequency and Reporting: Submit to OWNER, records of readings from various instruments and survey points.
    1. Record all shaft monitoring readings at least once per week starting prior to shaft construction and continuing until shaft has been backfilled and until no more detectable movement occurs.
    2. Immediately report to OWNER any movement, cracking, or settlement which is detected.
    3. Following substantial completion but prior to final completion, make final survey of all shaft related monitoring points.

4.52.1.6 Disposal of Excess Material

a) Remove spoil in accordance with Technical Specification 4.3.18, "Disposal of Excess Excavated Materials".

4.52.2 Measurement and Payment

a) Unit Prices.
    1. Tunnel shafts, both those shown on the Plans and those additional ones needed for Contractor's operations, are bid as lump sum for all shafts, collectively. Prior to construction, provide schedule of values. Itemize cost by station for each shaft designated on the Plans and additionally required for construction operations. Seventy-five percent (75%) of itemized amount will be submitted on pay estimate upon shaft installation; twenty-five percent (25%) will be submitted on pay estimate upon backfill and site restoration (including topsoil, sodding and hydro-mulching). Payment will include excavation, disposal of excavated materials, ground support systems, backfilling, and cleanup. Manholes constructed in tunnel shafts are to be paid separately at contract unit price as specified in Technical Specification 4.25, "Closed Bottom Fiberglass Manhole – Type A" and Technical Specification 4.48, "Fiberglass Manhole Liner".
    2. Removal and replacement of surface improvements necessary for shaft construction, including but not limited to sidewalks, asphaltic or concrete pavement, base and subbase, curbs, curb and gutter, driveways, topsoil, sodding, and hydro-mulch shall be included in lump sum for tunnel shafts.
    3. Pay for relocation of City-owned utilities at contract unit price, only when included in on the Bid Evaluation Form.

b) Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

c) Unit Prices for water main Projects.
    1. Payment will be made for construction of tunnel shafts and related work on a lump sum basis only if detailed as lump sum on the Bid Evaluation Form. If work is not detailed as lump sum on the Bid Evaluation Form, include the cost for construction of tunnel shafts in unit price for related items.
    2. Unless otherwise shown on the Plans removal and replacement of surfaces

necessary for shaft construction, including but not limited to sidewalks, asphaltic and correct pavement, base and sub-base shall be paid to limits no further than five feet (5') from shaft wall.

4.56 – Disinfection & Bacteriological Testing Connection to Existing Water Mains

4.56.0 General

This item shall govern the Contractor's disinfection and bacteriological testing of piping associated with the connections to existing water mains. Disinfection and Bacteriological Testing of new and existing piping shall be conducted in accordance with COSA standards and specifications, TCEQ Rules and ANSI/AWWA Standard C651-14 Disinfecting Water Mains; hereinafter referred to as "the Standards". In instances where this item conflicts with the Standards the more stringent requirement shall be followed.

4.56.1 Method

COSA shall collect a sample in the area of the connection and perform its own bacteriological test in order to verify the water supplied by COSA Distribution System is not contaminated prior to Contractor beginning connection work. Notify COSA Inspector no less than 48 hours prior to connection work beginning. The COSA Inspector will provide a copy of the successful test report to the contractor and authorize the work to begin. COSA shall not be responsible for the water quality in the existing or new connection piping thereafter. Work shall not begin prior to COSA Inspector's authorization.

Contractor is solely responsible for the water quality within the new and existing isolated piping after connection work is complete. Contractor shall chlorinate, flush and perform bacteriological testing until such time testing verifies the connection piping is not contaminated.

In completing the work Contractor shall implement the actions detailed in the most current version of TAC 290.47(e) – Special Precautions Flowchart (attached for reference). In instances where the Special Precautions Flowchart requires TCEQ notification and additional action the Contractor shall immediately notify COSA Water Utilities Office. COSA will notify TCEQ and issue appropriate Public Notices. Contractor shall coordinate with COSA to perform additional work needed to comply with TCEQ requirements. Such additional work is at the Contractor's sole expense.

It is desirable that the Contractor develop or construct a "controlled" connection in which water and other contaminants are prevented from entering the existing/new piping and disinfection is accomplished as detailed in ANSI/AWWA C651-14, Section 4.11.3.2 – Controlled pipe repair with depressurization after shutdown. Briefly described it consists of a scouring flush, 1% chlorine solution swab/spray, connect, flush and bacteriological testing.

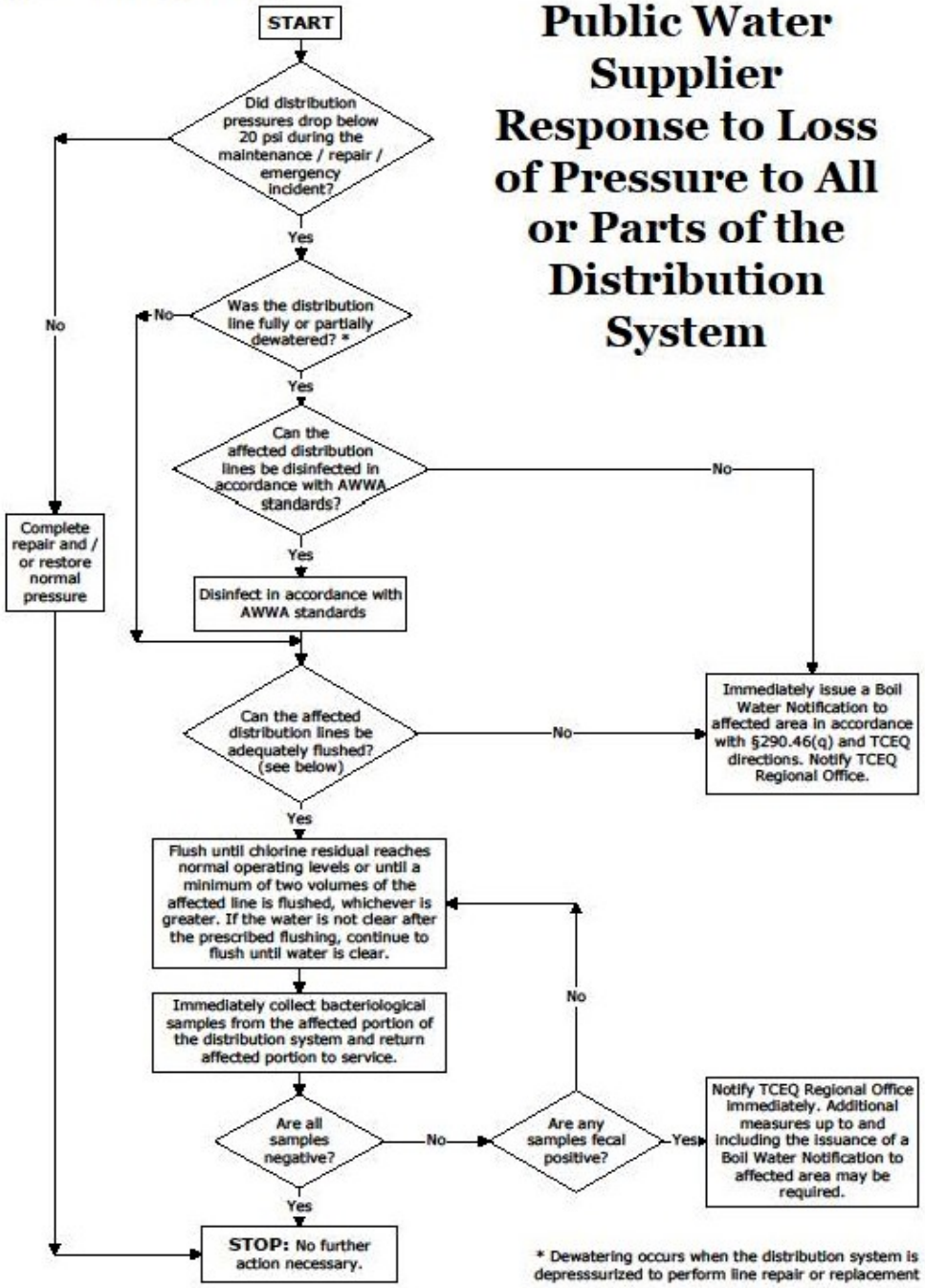
In general chlorination, flushing and sampling shall be accomplished via existing pipe appurtenances. Coordinate locations with COSA Inspector. Where existing appurtenances are not available Contractor shall install a port consisting of a tapping saddle, 1" corporation valve, short copper line and an angle stop.

Contractor may backfill and establish service prior to test results.

4.56.3 Measurement and Payment

Except the installation of a port, the work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly, but is subsidiary to the connection bid item(s). Port installation shall be measured as each and paid as a 1" service connection. No payment shall be made for additional work performed after a failed water quality assessment of the new/existing connection piping as it is the Contractor's responsibility to have a passing test.

Figure: 30 TAC §290.47(e)



PART II –CITY STANDARD TRANSPORTATION TECHNICAL SPECIFICATIONS

CITY OF SAN ANGELO

ITEM 100

PREPARING RIGHT-OF-WAY

100.1. DESCRIPTION.

This Item shall govern the clearing and grubbing for the preparation of the Right-of-Way for construction operations by the removal and disposal of all obstructions from the Right-of-Way and from designated easements, where removal of all such obstructions is not otherwise shown on the Plans and specifications.

Such obstructions shall be considered to include remains of houses, foundations, floor slabs, concrete, brick, lumber, plaster, septic tank drain fields, basements, abandoned utility pipes or conduits, equipment, fences, retaining walls, outhouses, and shacks.

This Item shall also include the removal of trees and shrubs and other landscape features not designated for preservation, stumps, brush, roots, vegetation, logs, curb and gutter, driveways, paved parking areas, miscellaneous stone, sidewalks, drainage structures, manholes, inlets, abandoned railroad tracks, scrap iron and debris, whether above or below ground except live utility facilities.

100.2. CONSTRUCTION METHODS.

(1) General. All areas as shown on the Plans, shall be cleared of all structures and obstructions as defined above. Those trees, shrubs and other landscape features specifically designated by the City for preservation shall be carefully protected from abuse, marring, or damage during construction operations. Continual parking and/or servicing of equipment under the branches of trees marked for preservation will not be permitted. When trees and shrubs are designated for preservation and require pruning, they shall be trimmed as directed by the City and all exposed cuts over two (2) inches in diameter shall be treated with a material approved by the City.

Culverts, storm sewers, manholes and inlets shall be removed in proper sequence for maintenance of traffic and drainage.

Underground obstructions, except those items designated for preservation, shall be removed to the following depths:

(a) In areas to receive embankment: one (1) foot below natural ground, except when permitted by the Plans, trees and stumps may be cut off as close to natural ground as practicable on areas which are to be covered by at least three (3) feet of embankment.

(b) In areas to be excavated: one (1) foot below the low elevation of the excavation.

(c) All other areas: one (1) foot below natural ground.

(2) Disposal of Material. Unless otherwise shown herein, all materials and debris removed shall become the property of the Contractor, including all merchantable timber, and shall be removed from the Right-of-Way and disposed of in a manner satisfactory to the City, except that gravel, brick, stone, or broken concrete, when approved by the City, may be used in the roadway embankment. This material shall conform to the requirements of Item 132, "Embankment".

(a) State or National Forest or Park: The provisions shown on the Plans for removal of the timber shall apply. No timber shall be cut or defaced outside of the Right-of-Way lines or material pit limits as indicated on the Plans or by the City.

(b) Burning of Brush: When burning of brush is permitted under applicable laws and by the City, the following shall govern.

(i) Where construction is on new location, the brush shall be piled and burned in the center of the work area.

(ii) When a portion of the project falls within the limits of a state or National Forest or Park, the Contractor shall notify the responsible agencies prior to any burning.

(3) Backfill. Holes remaining after removal of all obstructions, objectionable material, trees, stumps, etc., shall be backfilled with approved material, compacted and restored to approximately its original contours by blading, bulldozing, or by other methods, as approved by the City. In areas to be immediately excavated, the backfilling of holes may not be required when approved by the City.

Before backfilling, the remaining ends of all abandoned storm sewers, culverts, conduits, and water or gas pipes over 3 inches in diameter, shall be plugged with an adequate quantity of concrete to form a tight closure.

100.3 MEASUREMENT.

(1) Methods of Measurement. This Item will be measured by one of the following methods:

(a) Preparing Right-of-Way (Acre). The work performed will be measured by the by the nearest tenth of an acre of Right-of-Way as shown on the Plans.

(b) Preparing Right-of-Way (Station). The work performed will be measured by the "100-Foot Station" regardless of the width of the Right-of-Way as shown on the Plans.

(c) Preparing Right-of-Way (Tree). The work performed will be measured by each tree removed of the diameter specified.

(2) General. Measurement for payment for "Preparing Right-of-Way (Acre)" and for "Preparing Right-of-Way (Station)" will be made only on areas indicated and classified on the Plans as "Preparing Right-of-Way". Work required by the City on additional areas (such as additional Right-of-Way, additional cut and embankment areas, etc.) shall be measured as specified above.

Areas other than those set forth above will not be measured for payment.

100.4. PAYMENT.

The work performed and material furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Preparing Right-of-Way," and/or "Preparing Right-of-Way (Trees)" of the diameter specified. This price shall be full compensation for trimming designated trees and shrubs; for removal and disposal of all obstructions and debris; for backfilling all holes; for furnishing and placing all concrete for plugs; for restoring areas to original condition; and for all labor, equipment, tools and incidentals necessary to complete the work.

All work performed in areas not so designated on the Plans as "Preparing Right-of-Way," except "additional areas" as defined under "Measurement" or specifically covered otherwise, will not be paid for directly but shall be considered as subsidiary work pertaining to the various bid items.

The total payment for this Item will not exceed ten (10) percent of the original contract amount until after the completion of the entire contract work to the satisfaction of the City. That portion of the contract amount for this Item in excess of ten (10) percent of the total contract amount will then be paid on the next estimate after the work is accepted and after the partial release of retainage.

CITY OF SAN ANGELO

ITEM 107

SEEDING FOR EROSION CONTROL

107.1 DESCRIPTION.

Seeding for Erosion Control shall consist of preparing the areas, providing for sowing of seeds, mulching with straw, hay or cellulose fiber and other management practices for the cut slopes and for the bottom of the channel detention pond area, embankments, dikes, beams and the other areas as shown on the Plans or as directed by the City excluding the rock surface in accordance with these specifications.

107.2 SEEDS.

All seeds shall meet the requirements of the Texas Seed Law including the labeling requirements for showing pure live seed, name and type of seed.

The pure live seed mixture shall consist of the following seeds in the amount noted per acre of planting area.

Green Sprangletop	- 1.2 lbs.
Common Bermuda	- 8.0 lbs.
Klien	- 1.0 lbs.
Perennial Rye	- 2.0 lbs.

Fertilizer, if specified on the Plans, shall be delivered in bags or containers clearly labeled showing the analysis. The fertilizer, if requested by the City, will be subject to testing by the Texas Department of Agriculture in accordance with the Texas Fertilizer Law. A pelleted or granulated fertilizer shall be used which has the analysis shown on the Plans. The rate of application shall be as shown on the Plans.

Straw mulch shall be oat, wheat, or rice straw. Hay mulch shall be prairie grass, Bermuda grass or other acceptable hay. The mulch shall be free of noxious weeds and foreign materials. It shall be kept in a dry condition and shall not be molded or rooted.

107.3 CONSTRUCTION METHODS.

After the areas designated for seeding are cut to the lines, grades, cross sections and to the configurations shown on the Plans, the area shall be cultivated to a depth of at least four inches. The seed bed shall be cultivated sufficiently to reduce the soil to a state of good tilth for proper germination of the grass seeds. The cross-section and configuration previously established shall be maintained throughout the process of cultivation and any necessary reshaping shall be done prior to planting of the seeds.

The seed mixture shall be uniformly distributed over the areas shown on the Plans or where directed by the City by the mechanical equipment. Seed and fertilizer (if called on the Plans) may be distributed at the same time provided that each component is uniformly applied at the specified rate. After planting, the planted area shall be rolled with corrugated roller of the "cultipacker" type. All rolling of the slope areas shall be on the contours. For areas smaller than half an acre, sowing of seeds by hand will be permitted. If sown by hand, the seeds shall be sown in two (2) directions at right angles to each other. Upon completion of planting of the seeds, straw or hay mulch shall be spread uniformly over the seeded area at the rate of approximately one half (1/2) to two (2) tons of hay or two (2) to two and a half tons (2 1/2)of straw per acre. The Contractor in lieu of placing the mulch by hand may use a mulching machine to shoot the mulch over the seeded area. If permitted by the City, cellulose fiber may be used in place of straw or hay mulch. The application rate for cellulose fiber as mulch shall be a minimum of twenty five hundred (2,500) lbs. per acre of area with flat surface and minimum of three thousand (3,000) lbs. per acre of area with sloped surfaces (greater than 10 percent).

Water shall be free of industrial wastes and other objectionable material. Water source to be approved by the City.

The criterion for acceptance of the work under this Item is "Good Stand of Grass." The "Good Stand of Grass" is defined as a minimum of one-half (1/2) inch of well established live grass covering at least 75 percent of the area designated for seeding. If it is necessary, the bald spots in the seeded area shall be selectively reseeded at the direction of the City.

107.4 METHOD OF MEASUREMENT.

The work performed in accordance with the specifications described herein will be measured by the acres, complete in place.

107.5 PAYMENT.

The work performed, materials furnished and measured will be paid for at the unit price bid for "Seeding for Erosion Control" which shall be full compensation for furnishing all materials and for performing all operations necessary to complete the work in an acceptable manner.

If the Contractor were to fail to provide the requirements of this Item as specified herein, the Owner shall reserve the right to engage another Contractor to complete the work and the cost thereof shall be deducted from monies payable to the Contractor for this Item.

CITY OF SAN ANGELO

ITEM 110

EXCAVATION

110.1. DESCRIPTION.

This Item shall govern for the roadway, channel and/or special excavation of the required material in the areas shown on the Plans and cross sections to the lines, grades, and typical sections as specified. Excavation shall include all materials encountered regardless of their nature or of the manner in which they are removed.

110.2. CONSTRUCTION METHODS.

All excavation shall be performed as specified herein and the completed roadway and/or channels shall conform to the alignment, grades, and typical sections as shown on the Plans or project cross sections or as established by the City.

Unsuitable excavation and excavation in excess of that needed for construction shall be known as "Waste" and shall become the property of the Contractor to be disposed of by him outside the limits of the right-of-way at a location approved by the City. Unsuitable material encountered below subgrade elevation in roadway cuts, when declared "Waste" by the City, shall be replaced with material from the roadway excavation or with other suitable material as approved by the City. This work shall be done in accordance with the provisions of the applicable bid items.

When excavated materials, including topsoil, are utilized in constructing the required roadway sections, payment of replacement will be made under the pertinent placement specification.

During construction the roadbed and ditches shall be maintained in such condition as to insure proper drainage at all times. Ditches and channels shall be so constructed and maintained as to avoid damage to the roadway section. During construction, channels shall be kept drained, insofar as practicable, and the work shall be prosecuted in a neat and workmanlike manner.

All slopes shall be accurately shaped, and care shall be taken that no material is loosened below or outside the required slopes. Exceptions shall be those slopes in rock or other material where, in the judgment of the City, some variation may be permitted. All breakage and slides shall be removed and disposed of in a manner acceptable to the City.

(1) Rock Cuts. The Contractor shall have the following options:

(a) Nonhomogeneous Rocks:

(i) Excavate to finish subgrade elevation, manipulate and compact the subgrade in accordance with Section 132.3.(3).(a) without removal.

(ii) Excavate below grade (undercutting) and replace with embankment material approved by the City. Compaction shall be in accordance with Section 132.3.(3).(a).

(b) Homogeneous Rock.

(i) Excavate to finish subgrade elevation.

(ii) Excavate to finish subgrade elevation, manipulate and compact the subgrade in accordance with Section 132.3.(3).(a) without removal.

(iii) Excavate below grade (undercutting) and replace with embankment material, limestone base material, or other material approved by the City. Compaction shall be in accordance with Section 132.3(3).(a).

(2) Earth Cuts. When base and/or pavement structure is placed under this project, all earth cuts shall be scarified to a uniform depth of at least six inches below the required finished subgrade elevation for the entire roadbed width. The material shall be mixed and reshaped by blading and then sprinkled and rolled in accordance with Section 132.3.(3).(a) or as shown on the Plans.

(3) Subgrade Tolerances. Tolerances shall be as follows:

(a) Stage Construction. Any deviation in excess of 0.1 foot in cross section and 0.1 foot in 16 feet measured longitudinally shall be corrected by loosening, adding or removing the material, reshaping and recompacting by sprinkling and rolling.

(b) Turn Key Construction. Any deviation in excess of half inch in cross section and half inch in 16 feet measured longitudinally shall be corrected by loosening, adding or removing the material, reshaping and recompacting by sprinkling and rolling.

110.3. MEASUREMENT.

This Item will be measured by the cubic yard in its original position as computed by the method of average end areas.

This is a Plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract Plans, except as may be modified by special condition. If no adjustment of quantities is required, additional measurements or calculations will not be required.

Shrinkage or swellage factors will not be considered in determining the calculated quantities.

110.4. PAYMENT.

The work performed and materials furnished in accordance with the Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Excavation (Roadway)," "Excavation (Channel)." "Excavation (Special)" or "Excavation (Roadway and Channel)." This price shall be full compensation for all authorized excavation; for the undercutting subgrade and reworking or replacing the undercut material; for all hauling; for all work required for disposal of material not used elsewhere on the project and for furnishing all labor, materials, tools, equipment and incidentals necessary to complete the work.

CITY OF SAN ANGELO

ITEM 132

EMBANKMENT

132.1 DESCRIPTION.

This Item shall govern for the placement and compaction of all materials necessary for the construction of roadway embankments, levees, and dykes or any designated section of the roadway where additional material is required.

132.2 MATERIAL.

Materials may be furnished from required excavation in the areas shown in the Plans or from off right-of-way sources obtained by the Contractor and meeting the requirements herein. All embankment shall consist of suitable earth material such as rock, loam, clay, or other such materials as approved by the City that will form a stable embankment.

132.3 CONSTRUCTION METHODS.

(1) General. Prior to placing any embankment, all work in accordance with Part II – Construction Details, Item 100, "Prepare Right-of-Way", shall have been completed on the areas over which the embankment is to be placed. Stump holes or other small excavation in the limits of the embankments shall be backfilled with suitable material and thoroughly tamped by approved methods before commencing embankment construction. The surface of the ground, including disk-loosened ground or any surface roughened by small washes or otherwise, shall be restored to approximately its original slope by blading or other methods. Where shown on the Plans or required by the City, the ground surface thus prepared shall be compacted by sprinkling and rolling.

The City shall be notified sufficiently in advance of opening any material source to allow performance of any required testing.

Unless otherwise shown on the Plans, the surfaces of unpaved areas (except rock) which are to receive embankment shall be loosened by scarifying to a depth of at least six inches. Hillsides shall be cut into steps before embankment materials are placed. Placement of embankment materials shall begin at the low side of hillside and slopes. Materials which have been loosened shall be recompacted simultaneously with the new embankment materials placed upon it. The total depth of loosened and new materials shall not exceed the permissible depth of the layer to be compacted.

Trees, stumps, roots, vegetation or other unsuitable materials shall not be placed in embankment.

Unless otherwise shown on the Plans, all embankments shall be constructed in layers approximately parallel to the finished grade of the roadbed.

Embankments shall be constructed to the grade sections shown on the Plans or as established by the City. Each section of the embankment shall correspond to the detailed section or slopes established by the City. After completion of the roadway, it shall be continuously maintained to its finished section and grade until the project is accepted.

(2) Constructing Embankments.

(a) Earth Embankments: Earth embankments shall be defined as those composed principally of material other than rock, and shall be constructed of acceptable material from approved sources.

Unless otherwise specified, earth embankments shall be constructed in successive layers for the full width of the individual roadway cross section and in such lengths as are best suited to the sprinkling and compacting methods utilized.

Layers of embankment may be formed by utilizing equipment and methods which will evenly distribute the material.

A minor quantity of rock or broken concrete encountered in the construction of this project may be incorporated in the lower layers of the embankment if acceptable to the City. Or, it may be placed in the deeper fills, in accordance with the requirements for the construction of rock embankments, provided such placement of rock is not immediately adjacent to structures or in areas where bridge foundations are to be constructed. Also, rock or broken concrete may be placed in the portions of embankments outside the limits of the completed roadbed width where the size of the rock or broken concrete prohibits its incorporation in the normal embankment layers. All exposed reinforced steel shall be cut and removed from the broken concrete.

Each layer of embankment shall be uniform as to material, density and moisture content before beginning compaction. Where layers of unlike materials abut each other, each layer shall be featheredged for at least 100 feet, or the material shall be so mixed as to prevent abrupt changes in the soil. No material placed in the embankment by dumping in a pile or windrow shall be incorporated in a layer in that position, but all such piles or windrows shall be moved by blading or similar methods. Clods or lumps of material shall be broken and the embankment material mixed by blading, harrowing, disking or similar methods until a uniform material of uniform density is achieved in each layer.

It shall be the responsibility of the Contractor to secure a uniform moisture content throughout the layer by such methods as may be necessary.

(b) Embankment Adjacent to Culverts: As a general practice, embankment material placed adjacent to any portion of any structure and in the first two (2) layers above the top of any culvert or similar structure shall be free of any appreciable amount of gravel or stone particles more than four inches in greatest dimension and of such gradation as to permit thorough compaction. When, in the opinion of the City, such material is not readily available, the use of rock or gravel mixed with earth will be permitted, in which case no particle larger than 12 inches in greatest dimension and six (6) inches in least dimension may be used. The percentage of fines shall be sufficient to fill all voids and insure a uniform and thoroughly compacted mass of proper density.

(3) Compaction Method. Compaction of embankments shall be by "Ordinary Compaction" or "Density Control" as shown on the Plans.

(a) Ordinary Compaction. When "Ordinary Compaction" is shown on the Plans, the following provisions shall govern:

Each layer shall not exceed eight (8) inches of loose depth, unless otherwise directed by the City. Each layer shall be compacted in accordance with the provisions governing the Item or Items of "Rolling". Unless otherwise specified on the Plans, the rolling equipment shall be as approved by the City. Compaction shall continue until there is no evidence of further compaction. Prior to and in conjunction with the rolling operation, each layer shall be brought to the moisture content directed by the City, and shall be kept leveled with suitable equipment to insure uniform compaction over the entire layer. Should the subgrade, for any reason or cause, lose the required stability or finish, it shall be recompacted and finished at the Contractor's expense.

(b) Density Control. When "Density Control" is shown on the Plans, the following provisions shall apply:

Each layer shall be compacted to the required density by any method, type and size of equipment which will give the required compaction. The depth of layers, prior to compaction, shall depend upon the type of sprinkling, mixing and compacting equipment used. However, maximum depth (16 inches loose and 12 inches compacted) shall not be exceeded unless approved by the City. Prior to and in conjunction with the rolling operation, each layer shall be brought to the moisture content necessary to obtain the required density and shall be kept leveled with suitable equipment to insure uniform compaction over the entire layer.

Each layer shall be sprinkled and compacted to the extent necessary to provide the density specified below, unless otherwise shown on the Plans.

DESCRIPTION	DENSITY, PERCENT	MOISTURE
Non-Swelling Soils with plasticity index less than 20	Not less than 95	+/- 2% of optimum
Swelling soils with plasticity index of 20 to 35	Not less than 95	+/- 2% of optimum
Swelling soils with plasticity index over 35	Not less than 95	+/- 2% of optimum

The density determination will be made in accordance with Test Method Tex-114-E / ASTM D 698.

Field density determination by nuclear gage will be made in accordance with Test Method Tex-115-E / ASTM D 2922 for field density and ASTM D 3017 for moisture content.

After each layer of earth embankment is complete, tests as necessary may be made by the City. When the material fails to meet the density requirements or should the material lose the required stability, density, moisture or finish before the next course is placed or the project is accepted,

the layer shall be reworked as necessary to obtain the specified compaction, and the compaction method shall be altered on subsequent work to obtain specified density. Such procedure shall be subject to the approval of the City.

Excessive loss of moisture shall be construed to exist when the subgrade soil moisture content is four percent less than the optimum.

The Contractor may be required to remove a small area of the layer in order to facilitate the taking of density tests. Replacement and compaction of the removed material in the small area shall be at the Contractor's expense.

132.4 TOLERANCES.

The tolerances shall be as follows:

(1) Grade Tolerances.

(a) Stage Construction: Any deviation in excess of 0.1 foot in cross section and 0.1 foot in 16 feet measured longitudinally shall be corrected by loosening, adding or removing the material, reshaping and recompacting by sprinkling and rolling.

(b) Turnkey Construction: Any deviation in excess of 1/2 inch in cross section and 1/2 inch in 16 feet measured longitudinally shall be corrected by loosening, adding or removing the material, reshaping and recompacting by sprinkling and rolling.

(2) Density Tolerances. The City may accept the work provided not more than one out of the most recent three (3) density tests performed is outside the specified density and provided that the failing test is no more than three (3) pounds per cubic foot outside the specified density.

132.5. MEASUREMENT.

This Item will be measured as follows:

(1) General. Shrinkage or swellage factors will not be considered in determining the calculated quantities.

(2) Class 1. Embankment will be measured in its original, natural position, and the volume computed in cubic yards by the method of average end area.

(3) Class 2. Embankment will be measured by the cubic yard in vehicles as delivered on the road.

(4) Class 3. Is a Plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract Plans, except as may be modified by General Note. If no adjustment of quantities is required, additional measurements or calculations will not be required.

132.6. PAYMENT.

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Embankment", of the compaction method, type and class specified. This price shall be full compensation for furnishing embankment; for hauling; for placing, compacting, finishing and reworking; and for all labor, royalty, tools, equipment and incidentals necessary to complete the work.

When "Ordinary Compaction" is shown on the Plans, all sprinkling and rolling will not be paid for directly, but will be considered subsidiary to this Item, unless shown on the Plans.

When "Density Control" is shown on the Plans, all sprinkling and rolling will be considered subsidiary to this Item.

When subgrade is constructed under this project, correction of soft spots in the subgrade will be at the Contractor's expense.

CITY OF SAN ANGELO

ITEM 360

CONCRETE PAVEMENT

360.1. DESCRIPTION.

This item shall govern for the construction of Portland Cement Concrete pavement with or without monolithic curbs on a prepared subgrade or sub-base course, in accordance with the typical sections shown on the Plans, the lines and grades established by the City and the requirements herein.

360.2. PAVING CONSTRUCTION PLAN.

The Contractor shall submit a paving construction plan for approval by the City prior to beginning pavement construction operations. The plan shall contain the mix design, methods of construction, and description of equipment to be used in mixing, placing, finishing, curing, and miscellaneous materials.

360.3. MATERIALS.

Unless otherwise shown on the Plans or required herein, all materials shall conform to the requirements of the pertinent Items of City of San Angelo Standard Specifications for Construction as follows:

Item 300, "Asphalts, Oils, and Emulsions"
Item 420, "Concrete Structures"
Item 421, "Portland Cement Concrete"
Item 433, "Joint Sealants and Fillers"
Item 437, "Concrete Admixtures"
Item 440, "Reinforcing Steel"
TxDOT Item 526, "Membrane Curing"

except for the following:

(1) Portland Cement Concrete. Classification and mix design shall conform to Class "P" Portland Cement Concrete as defined in Item 421, "Portland Cement Concrete", unless otherwise shown on the Plans.

(2) Joint Sealants and Fillers. These materials shall be of the size, shape and type shown on the Plans.

Unless otherwise shown on the Plans, the joint sealant materials to be used shall be self-leveling silicone pavement sealant as manufactured by Dow Corning, Crafco, Inc., or approved equal.

(3) Dowels for Expansion and Contraction Joints. Dowels shall be smooth, straight steel dowels of the size and type shown on the Plans and shall conform to the requirements of ASTM A615, Grade 60. The free end of dowels shall be smooth and free of burrs.

Coat dowels with a thin film of grease or other approved de-bonding material. Provide dowel caps on the lubricated end of each dowel bar used in an expansion joint. Provide dowel caps filled with a soft compressible material with enough range of movement to allow complete closure of the expansion joint.

(4) Positioning and Support Devices for Reinforcement and Joint Assemblies. These devices shall be of sufficient structural quality to prevent movement of the dowels or steel reinforcement during concrete placement and finishing. The devices shall be a type approved by the City.

Positioning and supporting devices (chairs) for steel reinforcement bars shall be either plastic or metal and of sufficient number to maintain the position of the bars within the allowable tolerances.

(5) Reinforcing Steel. ASTM A616 Grade 60 will be permitted for straight bars only. Reinforcing steel that requires bending shall be ASTM 615 Grade 40 with the spacing reduced to two thirds (2/3) of that shown for Grade 60 reinforcing steel. When shown on the Plans, corrosion protection shall be applied to dowels and tie bars.

(a) Tie Bars. Tie bars at weakened plane longitudinal joints shall be straight reinforcing bars. Tie bars at longitudinal construction joints shall be either multiple piece tie bars or straight reinforcing bars, when equipment or conditions permit.

(b) Multiple Piece Tie Bars. Multiple piece tie bars (threaded coupling or other adequate devices) shall develop a tensile strength over their entire length equal to 1-1/4 times the yield strength of the tie bars shown. Each end of multiple piece tie bars shall consist of deformed reinforcement of at least the size shown on the Plans, conforming to City of San Angelo Item 440, “Reinforcing Steel”.

360.4. EQUIPMENT.

(1) General. All equipment shall be maintained in good condition and approved by the City before the Contractor will be permitted to begin construction of the pavement. Weighing, measuring equipment and mixer at Portland Cement Concrete Plant, hauling equipment, agitator trucks, grade control equipment, shall conform to the requirements set forth in applicable City of San Angelo Specifications relative to production and installation of Portland Cement Concrete Pavement.

(2) Forms.

(a) Side Forms. Side forms shall be of metal except as otherwise provided herein and shall be of approved cross section. The length of form sections shall not be less than ten (10) feet, and each section shall provide for staking in position with not less than three (3) pins. Forms shall be of ample strength and shall be provided with adequate devices to secure them in place so the forms

will withstand, without visible springing or settlement, the impact and vibration of the spreading and finishing machinery. In no case shall the base of the form be less than eight (8) inches wide for a form depth of eight (8) inches or more in height. The forms shall be free from warps, bends or kinks, and shall be sufficiently true to provide a reasonably straight edge on the concrete.

Flexible or curved forms of wood or metal of proper radius shall be used for curves of 100-foot radius or less.

(b) Curb Forms. Outside curb forms shall be of wood or metal of a section satisfactory to the City, straight, free of warp, and shall be of a depth at least equal to the depth of the curb. They shall be securely mounted on the paving forms and maintained in true position during the placing of the concrete. Inside curb forms, if required, shall be of approved material and of such design as to provide the curb required and shall be rigidly attached to the outside curbs forms.

(3) Equipment for Spreading, Consolidating, Finishing Surface Texturing Concrete shall conform to the requirements set forth in Item 360, "Concrete Pavement".

360.5. QUALITY OF CONCRETE.

The quality of concrete shall be in accordance with Item 421, "Portland Cement Concrete".

360.6. SUBGRADE.

(1) Preparation of Subgrade or Subbase. The concrete pavement shall be constructed on prepared subgrade. When Slip Form equipment is used, a firm subgrade or subbase (stabilized or unstabilized) shall be maintained outside the limits of the pavement for the support of the Slip Form equipment. Refer to Item 200, "Subgrade Preparation" for additional information.

360.7. PLACEMENT OF REINFORCING STEEL AND JOINT ASSEMBLIES.

All reinforcing steel, including steel wire fabric reinforcement, tie bars, dowel bars, and load transmission devices shall be accurately placed and secured in position in accordance with Item 440, "Reinforcing Steel", and additional requirements set forth in Item 360, "Concrete Pavement".

360.8. CONCRETE MIXING AND PLACING.

(1) Mixing. Concrete mixing shall be in conformance with Items 421, "Portland Cement Concrete", and TxDOT Item 522, "Portland Cement Concrete Plants".

(2) Workability of Concrete. The concrete shall be workable, cohesive, possess satisfactory finishing qualities, and have a consistency conforming to the specified slump requirements. If detrimental bleeding occurs and this condition cannot be corrected by reasonable re-proportioning of the ingredients, the bleeding shall be immediately corrected by one or more of the following listed measures:

Redesign of the batch.
Addition of mineral filler to fine aggregate.

Increase of cement content.
Use of appropriate approved admixture.

When, in the opinion of the City, excessive bleeding occurs and corrective actions do not satisfactorily reduce bleeding, concrete placement operations shall cease until the concrete mixture has been redesigned.

When the method of transporting concrete produces excessive segregation and/or bleed water on the surface of the concrete, the method used shall be discontinued and a satisfactory method shall be provided. Such segregated concrete will be subject to rejection as directed by the City.

(3) Placing. Unless otherwise shown on the Plans, the concrete shall be placed using either forms or a slipform paver. Any concrete not placed as herein prescribed within the time limits specified will be rejected.

The Contractor shall provide a system satisfactory to the City for determining that concrete delivered to the site meets the specified requirements for mixing and time of placing as outlined under Item 360, "Concrete Pavement".

The concrete shall be placed as near as possible to its final location and in such manner as to minimize segregation and re-handling. Where hand spreading is necessary, concrete shall be distributed to the required depth by use of shovels. The use of rakes will not be permitted. Concrete shall be placed, consolidated and finished to conform to the required section and grade.

(a) Double Strike-Off Method. Unless otherwise shown on the Plans, when concrete placement is accomplished in two (2) lifts (double strike-off method) to allow placing the reinforcement after the first lift, the first lift shall be uniformly spread and/or struck off so that the final position of the longitudinal steel will be within one half (1/2) inch of the position shown on the Plans. The second lift shall be placed as soon as reinforcing steel is in place and prior to initial set of the first lift. The second lift shall not be placed later than 20 minutes after strike-off of the first lift.

(b) Placing Curbs. Where curbs are placed monolithically concrete for monolithic curbs shall be the same as for the pavement and must be placed while the pavement concrete is still plastic.

Where curbs are placed separately, they shall be placed in conformance with TxDOT Item 410, "Concrete Curb, and Gutter, Valley Gutter, Alley Apron, Driveways and Sidewalks".

(4) Consolidation. All concrete placed for pavement shall be consolidated by approved mechanical vibrators operated ahead of the finishing machine. Unless otherwise shown on the Plans, pan type vibrators shall be used for double lift placement of concrete and the immersion type vibrators shall be used for full-depth placement, unless otherwise approved by the City. Vibratory equipment shall extend across the pavement, but shall not come in contact with the side forms. Mechanically operated vibrators shall be mounted and operated in such manner as not to interfere with the transverse or longitudinal joints. Hand operated vibrators shall be used to consolidate concrete in areas not accessible to the machine mounted vibrators.

360.9. JOINTS.

(1) General. All transverse and longitudinal joints, when required in the pavement, shall be of the type or alternate type shown on the Plans and shall be constructed at the required location and alignment, in relationship to the tie bars and joint assemblies, and in accordance with details shown on the Plans. Stakes, braces, brackets or other devices shall be used as necessary to keep the entire joint assembly in true vertical and horizontal position.

Careful workmanship shall be exercised in the construction of all joints to insure that the concrete sections are completely separated by an open joint or by the joint materials and to insure that the joints will be true to the required section. Joints shall be cleaned and sealed in accordance with Item 438, "Cleaning and/or Sealing Joints and Cracks (Portland Cement Concrete)". The sequence of construction of joints if deemed necessary shall be approved by the City.

Excessive spalling of the joint groove shall be repaired to the satisfaction of the City prior to the installation of the sealant.

When sawed joints are used, they shall be sawed to the depth as shown on the Plans as soon as sawing can be accomplished without damage to the pavement. Once sawing has commenced it shall be continued until completed and all such sawing must be completed within 12 hours of placement. Sawing must be accomplished even in rain and cold weather. Should the sawing for any day's placement fail to be completed within 12 hours, the following concrete placement shall be limited to the amount that was sawed on time. This limitation shall continue until the sawing crew demonstrates it can handle a larger volume of sawing. If marring of the surface occurs, the City may extend the 12-hour limit.

The Contractor shall keep a standby power driven concrete saw on the project at all times when concrete operations are under way.

When membrane curing is used, the part of the seal, which has been disturbed by sawing operations, shall be re-sprayed by the Contractor with additional curing compound.

(2) Expansion Joints. Transverse expansion joints shall be constructed in accordance with the details shown on the Plans. After the finishing machine and before the carpet drag and tining machines have passed over the joint the Contractor shall inspect the joint filler for correctness of position. The Contractor shall make any required adjustment in position of the filler and shall install the joint seal space form in accordance with the Plans. The concrete faces of the joint seal space shall be left true to line and section throughout the entire length of the joint.

(3) Weakened Plane Joints. Weakened plane joints shall consist of transverse contraction joints and longitudinal joints. Unless otherwise shown on the Plans, the transverse joints shall be formed or sawed perpendicular to the centerline and surface of the pavement.

The joints shall be constructed in the sequence of operations, as shown on the Plans.

Chalk line, string line, sawing template or other approved methods shall be used to provide a true joint alignment.

(4) Transverse Construction Joints.

When the placing of concrete is stopped, a bulkhead of sufficient cross sectional area to prevent deflection, accurately notched to receive the load transmission devices and shaped accurately to the cross section of the pavement shall be provided.

Intentional stoppage of the placing of concrete shall be either at an expansion joint or at a weakened plane joint, when load transmission devices are shown on the Plans. When the design for load transmission does not include dowels, intentional stoppage shall be in the middle of a slab.

When an unintended stoppage of the placing of concrete occurs, the Contractor shall immediately place the available concrete to a line and install the above described bulkhead at right angles to the centerline of the pavement, perpendicular to the surface and at the required elevation. Concrete shall be placed and finished to this bulkhead. Any concrete remaining on the subgrade ahead shall be removed and disposed of as directed by the City. When placement of concrete is resumed before the concrete has set to the extent that the concrete will stand on removal of the bulkhead, the new concrete shall be consolidated with the first. The edge created by construction joints of this type shall have a joint seal space and shall be sealed as required for contraction joints.

At transverse construction joints in continuously reinforced concrete pavement, the reinforcement or load transmission device immediately beyond the joint will be protected against vibration or impact by the Contractor until paving resumes.

(5) Longitudinal Construction Joints. Longitudinal construction joints shall be of the type and at the locations shown on the Plans.

(6) Joint Filler Boards. Joint filler boards shall be of the size, shape and type as shown on the Plans. Boards shall be anchored by appropriate methods against their displacement while placing concrete.

(7) Curb Joints. Joints in the curb shall be provided and shall be of the same type and location as the adjacent pavement. The expansion joint material shall be of the same thickness, type and quality as specified for the pavement. All expansion joints shall be carried through the curb.

When transverse sawed joints are provided for the pavement, the curb placement shall be delayed until all transverse joints in the pavement have been sawed. Dowel bars shall be placed as shown on the Plans while the pavement concrete is still plastic, unless otherwise approved by the City. The weakened plane joint in the monolithic curbs may be formed or sawed.

360.10 SPREADING AND FINISHING.

(1) Machine-Finishing. All concrete pavement shall be finished with approved self-propelled machines.

The consistency of the concrete as placed should allow the completion of all finishing operations without the addition of water to the surface. When field conditions require additional moisture for the final concrete surface finishing operation, the water shall be applied to the surface by a fine, light fog mist and the amount of water added shall be held to a minimum.

When required by the City, the Contractor shall perform sufficient checks with a long handled ten (10) foot straightedge on the plastic concrete to insure that the final surface will be within the tolerances specified below. The check shall be made with the straightedge parallel to the centerline. Each pass thereof shall lap half of the preceding pass. All high spots shall be removed and all depressions over 1/16-inch in depth shall be filled with fresh concrete and floated. The checking and floating shall be continued until the surface is true to grade and free of depressions, high spots, voids and rough spots.

Final finish shall consist of a combination of a carpet drag and metal tine finish, unless otherwise shown on the Plans. Final finish shall be completed before the concrete has attained its initial set.

The final finish shall be accomplished by first drawing the specified carpet drag longitudinally along the pavement. The actual contact surface shall be regulated so that a coarse texture satisfactory to the City is obtained.

Immediately following the carpet drag, the pavement surface shall be given a transverse metal-tine finish. The metal-tine device shall be operated to obtain randomly spaced grooves approximately 3/16-inch deep, with minimum depth of 1/8-inch and approximately .083 inch wide. Successive passes of the tines shall not overlap a previous pass. Manual methods for achieving similar results may be used on ramps and other irregular sections of pavement.

After completion of texturing, the edge of the slab and joints shall be carefully finished as directed by the City.

(2) Hand Finishing. Hand finishing if permitted shall conform to the requirements specified herein.

When hand finishing is permitted, the concrete shall be struck off with an approved strike-off screed to such elevation that, when consolidated and finished, the surface of the pavement shall conform to the required section and grade.

The pavement shall be straightedged prior to final finishing. Other operations and surface tests shall be as required for machine finishing.

360.11. CURING.

(1) General. All concrete pavement shall be cured for a period of not less than 72 hours from the beginning of curing operations. All exposed surfaces, including vertical surfaces of the placed concrete, shall be cured immediately after finishing operations have been completed, in accordance with the requirements specified herein.

Failure to maintain adequate curing shall be cause for immediate suspension of concreting operations.

The applied curing material may be removed as necessary to saw joints or to comply with the requirements for any surface test. The hardened concrete surface shall be maintained wet with a water spray, if required, and the curing material replaced immediately after completion of sawing, testing and any required surface correction.

(2) Polyethylene Film Curing. After the final finish and the concrete surface has attained initial set, the concrete surface shall be wetted with water, applied in the form of a fine spray and covered with the polyethylene film so placed and weighted as to remain in direct contact with the surface. The polyethylene film blanket shall be maintained in place continuously for not less than the specified curing period.

All joints shall be sealed in a manner acceptable to the City to provide a moisture-proof lap.

The polyethylene film blankets shall be adequately weighted to prevent displacement or billowing due to wind and the film folded down over the side of the pavement shall be secured by a continuous bank of earth or other approved material. Plowing of this windrow into place will not be permitted. Use of polyethylene film holes and cuts are not acceptable.

(3) Membrane Curing. After final finish and immediately after the free surface moisture has disappeared, the concrete surface shall be sprayed uniformly with a curing compound in accordance with the requirements set forth in TxDOT Item 526, "Membrane Curing".

Special care shall be taken to insure that the sides of the tining grooves are coated with the curing compound.

360.12. PROTECTION OF PAVEMENT AND OPENING TO TRAFFIC.

The pavement shall be closed to all traffic, including vehicles of the Contractor, until the concrete is at least four (4) days old. This period of closure to all traffic may be extended if in the opinion of the City, weather or other conditions may require an extension of the time of protection. When Type II cement is used one (1) additional day shall be required for a total of five (5) days.

At the end of this period the pavement may be opened for use by vehicles of the Contractor provided the gross weight (vehicle plus load) of such vehicles and/or equipment does not exceed 14,000 pounds. Such opening, however, shall in no manner relieve the Contractor from his responsibility for overall safety of the traffic and the general public.

On those sections of the pavement to be opened to traffic, all joints shall first be sealed and the pavement cleaned. Unless otherwise shown on the Plans, stable material shall be placed against the pavement edges before permitting vehicles thereon.

After the concrete in any section of pavement is seven (7) days old, such section of pavement may be opened to all traffic as directed by the City. When Type II cement is used one (1) additional day shall be required for a total of eight (8) days. For those sections of the pavement to be opened to traffic, all joints shall first be sealed, the pavement cleaned, stable material placed against the pavement edges unless otherwise shown on the Plans and all other work performed as required for the safety of traffic. Such opening, however, shall in no manner relieve the Contractor from his responsibility for overall safety of the traffic and the general public.

360.13. MEASUREMENT.

This Item will be measured by one of the following methods:

(1) Measurement by the Square Yard. When provided under this item, concrete pavement will be measured by the square yard of surface area of completed and accepted work. When concrete pavement is to be measured by the square yard and monolithic curb is required, monolithic curb will be considered as part of pavement. Surface area of the pavement will be computed by measuring dimensions to the back of monolithic curb.

If curb and gutter is poured separately, it shall be measured and paid in accordance with Item 529, "Concrete Curb, Gutter, and combined Curb and Gutter". Gutter, Alley Apron, Driveways, and Sidewalks and will not be included in the area of concrete pavement.

(2) Measurement by the Cubic Yard. When provided by this Item, concrete pavement, including monolithic curb when required, will be measured by the cubic yard computed on the basis of design depth of concrete pavement shown on the Plans.

360.14. PAYMENT.

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for this Item. This price shall be full compensation for furnishing concrete; for placing and adjusting forms; for furnishing and installing all reinforcing steel; for furnishing all materials for sealing joints and placing longitudinal, expansion and weakened-plane joints, including all steel dowel caps and load transmission devices required; for mixing, placing, finishing, curing and sawing concrete; for cleaning and sealing concrete joints; and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

CITY OF SAN ANGELO

ITEM 420

CONCRETE STRUCTURES

420.1. DESCRIPTION.

This Item shall govern for the construction of all types of structures involving the use of cast-in-place concrete. All structures shall be constructed in accordance with the details shown on the Plans and this Item.

420.2. MATERIALS.

(1) Concrete. All concrete shall conform to the provisions of Item 421, "Portland Cement Concrete".

The class of concrete for each type of structure or unit shall be as shown on the Plans, or by pertinent governing specifications.

(2) Reinforcing Steel. All reinforcing steel shall conform to the provisions of Item 440, "Reinforcing Steel".

(3) Expansion Joint Material. The following materials shall conform to the requirements of Item 433, "Joint Sealants and Fillers".

(a) Preformed Fiber Material. Preformed fiber expansion joint material shall conform to the dimensions shown on the Plans. Unless otherwise specified, "Preformed Bituminous Fiber Material" shall be used.

(b) Joint Sealing Material. Unless shown otherwise, the sealer shall be a "Low Modulus Silicone Sealant".

(c) Asphalt Board. Asphalt board shall conform to the dimensions shown on the Plans.

(d) Rebonded Neoprene Filler. Rebonded neoprene filler shall conform to the dimensions shown on the Plans.

(4) Waterstop.

(a) Rubber waterstop or polyvinyl chloride (PVC) waterstop shall be in conformance with TxDOT Item 435, "Elastomeric Materials".

(b) Other types **s**hall be as shown on the Plans.

(5) Curing Materials.

(a) Membrane curing shall conform to TxDOT Item 526, "Membrane Curing".

(b) Cotton mats shall consist of a filling material of cotton "bat" or "bats" (min. twelve (12) oz. per sq. yd.); covered with unsized cloth (min. six (6) oz. per sq. yd.); tufted or stitched to maintain stability; shall be free from tears; and shall be in good general condition.

(c) Polyethylene sheeting shall be four (4) mil. minimum thickness and free from visible defects. It shall be clear or opaque white except when the temperature during the curing period does not exceed 60°F or when applicable to control temperature during mass pours.

(d) Burlap-polyethylene mats shall be made from burlap impregnated on one (1) side with a film of opaque white pigmented polyethylene and free from visible defects.

(e) Laminated mats shall have not less than one layer of an impervious material such as polyethylene, vinyl plastic or other acceptable material (either as a solid sheet or impregnated into another fabric) and shall be free of visible defects.

(6) Admixtures. Concrete admixtures shall comply with the requirements of TxDOT Item 437, "Concrete Admixtures".

(7) Epoxy. Unless otherwise specified, epoxy materials shall conform to TxDOT Item 575, "Epoxy".

420.3. GENERAL REQUIREMENTS.

Before starting work, the Contractor shall inform the City fully of the construction methods he proposes to use, the adequacy of which shall be subject to the approval of the City.

Concurrence on the part of the City of any proposed construction methods, approval of equipment, or of form and falsework Plans does not relieve the Contractor of the responsibility for the safety or correctness of the methods, the adequacy of his equipment or from carrying out the work in full accordance with the contract.

Unless otherwise shown on the Plans, the time sequence in which construction operations may be carried on and in which completed structures may be opened to traffic shall be governed by the following:

(1) Superstructure members, forms, falsework, or erection equipment shall not be placed on the substructure before the concrete therein has attained a flexural strength of 425 psi.

(2) Storage of materials on completed portions of a structure will not be permitted until all curing requirements for those particular portions have been met.

(3) A minimum flexural strength of 340 psi will be required for the following:

(a) Forms erected on concrete footings supported by piling or drilled shafts.

(b) Forms on individual drilled shafts.

Such work may begin on spread footings and culvert footings, after the concrete therein has aged at least two curing days. Concrete may be placed as soon as the forms and reinforcing steel are approved.

(4) The support of tie beam and/or cap forms by falsework placed on previously placed tie beams will be permissible provided such beams have attained 425 psi flexural strength, curing requirements are completed, and the member is properly supported to eliminate stresses not provided for in the design.

(5) Bridges and direct traffic culverts shall not be opened to construction traffic or to the traveling public until authorized by the City in accordance with the following:

After the last slab concrete has been in place at least 14 days, authorization may be given for construction traffic on structures not to exceed three quarter (3/4) ton vehicles.

After the last slab concrete has been in place at least 21 days, authorization may be given for other construction traffic or for the traveling public when necessary. Vehicles exceeding the legal load limit will be allowed in accordance with TxDOT Item 6, "Control of Materials".

(6) Box culverts in fills may be opened to backfilling and compaction equipment when the concrete in the top slab has attained 425 psi flexural strength, and may be opened to other traffic as soon as sufficient backfill and/or embankment has been placed over the top to protect the culverts against damage from heavy construction equipment. The Contractor shall repair, at his expense, any damage inflicted on the culvert by construction traffic.

420.4. DRAINS.

Weep holes and roadway drains shall be installed and constructed as shown on the Plans.

420.5. EXPANSION JOINTS.

Joints and devices to provide for expansion and contraction shall be constructed in accordance with plan details and the requirements of this Item.

The bearing area under the expansion ends of concrete slabs and slab and girder spans shall be given a steel trowel finish, and finished to the exact grades required.

Bridging of concrete or mortar around expansion joint material in bearings and expansion joints shall be prevented.

All open joints and joints to be filled with expansion joint material shall be constructed using forms adaptable to loosening or early removal. To avoid expansion or contraction damage to the adjacent concrete, these forms shall be loosened as soon as possible after final concrete set to permit free movement of the span without requiring full form removal.

When a "Type A" joint is shown on the Plans, preformed fiber joint material shall be used in the vertical joints of the roadway slab, curb, median, or sidewalk and the top one (1) inch thereof shall be filled with the joint sealing material shown herein or shown on the Plans.

The sealer shall be installed in accordance with TxDOT Item 438, "Cleaning and/or Sealing Joints and Cracks (Portland Cement Concrete)", and the manufacturer's recommendations.

Where preformed fiber joint material is used, it shall be anchored to the concrete on one side of the joint by light wire or nails.

Finished joints shall conform to the plan details with the concrete sections completely separated by the specified opening or joint material.

Soon after form removal and again where necessary after surface finishing, all concrete shall be removed from within the joint opening to insure full effectiveness of the expansion joint.

420.6. CONSTRUCTION JOINTS.

The joint formed by placing plastic concrete in direct contact with concrete that has attained its initial set shall be deemed a construction joint. The term monolithic placement shall be interpreted to mean that the manner and sequence of concrete placing shall not create a construction joint.

Construction joints shall be of the type and at the locations shown on the Plans. Construction joints other than those shown on the Plans will not be permitted in bridge slabs. Additional joints in other members will not be permitted without written authorization from the City. When additional joints are authorized, they shall have details equivalent to those shown on the Plans for joints in similar locations.

Unless otherwise provided, construction joints shall be square and normal to the forms. Bulkheads shall be provided in the forms for all vertical joints.

Construction joints requiring the use of joint sealing material shall be as shown on the Plans.

A concrete placement terminating at a horizontal construction joint shall have the top surface roughened thoroughly as soon as practicable after initial set is attained.

The hardened concrete surface shall be thoroughly cleaned of all loose material, laitance, dirt or foreign matter and saturated with water. All free water shall be removed and the surface shall be in a moist condition when concrete and/or bonding grout is placed against it.

Forms shall be drawn tight against the existing concrete to avoid mortar loss and offsets at joints.

When shown on the Plans or in other specifications, the joint surface shall be coated with bonding mortar, grout or other specified material.

When shown on the Plans, Type V epoxy material shall be used for bonding fresh concrete to hardened concrete. The bonding epoxy shall be placed on a clean, dry surface and shall be tacky when the fresh concrete is placed.

420.7. SEAL FOR FOUNDATIONS.

Concrete for foundation seals, unless otherwise specified, shall be in accordance with Item 400, "Excavation and Backfill for Structures".

420.8. FALSEWORK.

Falsework shall be designed and constructed to safely carry the maximum anticipated loads, including wind loads, and to provide the necessary rigidity. Details of falsework construction shall be subject to review and approval by the City in accordance with the provisions of Section 420.3.

For evaluating the adequacy of job fabricated falsework, a weight of 150 pounds per cubic foot shall be assumed for concrete, and a live load allowance of 50 pounds per square foot of horizontal surface of the form work shall be included. The maximum stresses shall not exceed 125 percent of the allowable stresses used by the Department for the design of structures.

Commercially produced structural units used in falsework shall not exceed the manufacturer's maximum allowable working load for moment, and shear or end reaction. The maximum allowable working load shall include an allowance of 35 pounds per square foot of horizontal form surface and sufficient details and data shall be submitted to the City for approval.

All timber used in falsework shall be sound, in good condition, and free from defects which would impair its strength.

When wedges are used to adjust falsework to desired elevations, the wedges shall be used in pairs to insure even bearing. The use of wedges to compensate for incorrectly cut bearing surfaces will not be permitted. Wedges shall be hardwood or metal.

Sills or grillages shall be large enough to support the superimposed load without settlement, and unless founded on solid rock, shale or other hard materials, precautions shall be taken to prevent yielding of the supporting material.

Falsework, which cannot be founded on a satisfactory spread footing, shall be placed on piling or drilled shafts having a bearing capacity sufficient to support the superimposed load without settlement. Falsework piling shall be driven to the required resistance determined by the applicable formula given in TxDOT Item 404, "Driving Piling". Drilled shafts for falsework shall be designed to carry the superimposed load using both skin friction and point bearing.

Welding, when used, shall conform to the requirements of TxDOT Item 448, "Structural Field Welding". Each falsework bent shall be securely braced to provide the stiffness required with the bracing securely fastened to each pile or column it crosses.

The falsework shall be removed when no longer required. Falsework piling shall be pulled or cut off not less than six (6) inches below finished ground level. Falsework, piling or drilled shafts in a stream, lake, or bay shall be completely removed to a point specified by the City to prevent any obstruction to the waterway.

420.9. FORMS.

All forms shall be constructed in accordance with the following:

(1) General. Except where otherwise specified, forms may be of either timber or metal.

Forms for round columns exposed to view shall be of steel, except that other materials will be allowed with written permission of the City.

Studs, joists, wales or other devices used for form supports shall be of sufficient section and rigidity to withstand undue bulging or settling of the forms. Any device or method used for form support shall be subject to the approval of the City.

Forms shall be designed for the pressure exerted by a liquid weighing 150 pounds per cubic foot. The rate of placing the concrete shall be taken into consideration in determining the depth of the equivalent liquid. Job fabricated forms shall be designed for an additional live load of 50 pounds per square foot of horizontal surface. The maximum unit stresses shall not exceed 125 percent of the allowable stresses used by the City Engineering Department for the design of structures.

Commercially produced structural units used in formwork shall not exceed the manufacturer's maximum allowable working load for moment, shear or end reaction. The maximum working load shall include a live load of 35 pounds per square foot of horizontal form surface and sufficient details and data shall be submitted to the City for review.

Forms shall be practically mortar-tight, rigidly braced and strong enough to prevent bulging between supports and shall be maintained to the proper line and grade during concrete placement. Forms shall be maintained in a manner to prevent warping and shrinkage.

Offsets at form joints shall not exceed 1/16 inch. Form supports for slabs shall not be welded to the top flange of I-beams or girders except in accordance with the provisions of Section 420.3.

Deflections due to cast-in-place slab concrete and railing shown in the dead load deflection diagram shall be taken into account in the setting of slab forms.

All forms and footing areas shall be cleaned of any extraneous matter before placing concrete.

Permission to place concrete will not be given until all preparatory work is complete to the satisfaction of the City.

If, at any stage of placement, the forms show signs of bulging or sagging, the portion of the causing such condition shall be removed immediately, if necessary, and the forms shall be reset and securely braced against further movement.

(2) Timber Forms. Lumber for forms shall be properly seasoned, of good quality, and free from imperfections which would affect its strength or impair the finished surface of the concrete

Forms or form lumber to be reused shall be maintained clean and in good condition. Any lumber which is split, warped, bulged, marred, or has defects that will produce inferior work shall not be used and shall be promptly removed from the work.

Form lining will be required for all formed surfaces, except for the inside of culvert barrels, inlets, manholes and box girders; the bottom of bridge decks between beams or girders; surfaces that are subsequently covered by backfill material or are completely enclosed and any surface formed by a single finished board. Lining will not be required when plywood forms are used.

Form lining shall be of an approved type such as Masonite or plywood. Thin membrane sheeting such as polyethylene sheets shall not be used for form lining.

Commercial form liners used to imprint a pattern or texture on the surface of the concrete shall be as shown on the Plans and/or as approved by the City.

Forms may be constructed of plywood not less than one-half (1/2) inch in thickness. The grain of the face plies on plywood forms shall be placed parallel to the span between the supporting studs or joists.

Plywood used for forming surfaces which remain exposed shall be equal to that specified as B-B Plyform Class I or Class III Exterior of the U.S. Department of Commerce, National Institute of Standards and Technology, U.S. Product Standard, latest edition.

Studs and joists shall be spaced so that the facing form material remains in true alignment under the imposed loads.

Wales shall be spaced close enough to hold forms securely to the designated lines and scabbed at least four feet on each side of joints to provide continuity. A row of wales shall be placed near the bottom of each placement.

Facing material shall be placed with parallel and square joints and securely fastened to supporting studs.

Forms for surfaces receiving only an ordinary finish and exposed to view shall be placed with the form panels symmetrical, i.e., long dimensions set in the same direction. Horizontal joints shall be continuous.

Molding for chamfer strips or other uses shall be made of materials of a grade that will not split when nailed and which can be maintained to a true line without warping. Wood molding shall be mill cut and dressed on all faces. Unless otherwise provided herein or shown on the Plans, forms shall be filleted at all sharp corners and edges with triangular chamfer strips measuring three fourth (3/4) inch on the sides.

Except at structures where railing is to be attached, culvert headwall heights shall be adjusted as necessary to provide a maximum projection of three (3) inches above the roadway slope unless otherwise directed by the City. At the entrance of all culverts, a three-inch chamfer shall be provided along the bottom edge of the top slab. Reinforcing steel shall be adjusted as necessary to

provide a minimum 1-1/4 clear cover. No changes will be made in quantities and no additional compensation will be allowed for this work.

All forms shall be constructed to permit their removal without marring or damaging the concrete. The forms may be given a slight draft to permit ease of removal.

Metal form ties of an approved type or a satisfactory substitute shall be used to hold forms in place and shall be of a type that permits ease of removal of the metal as hereinafter specified.

All metal appliances used inside of forms for alignment purposes shall be removed to a depth of at least one-half (1/2) inch from the concrete surface. The appliances shall be made so the metal may be removed without undue chipping or spalling of the concrete, and when removed, shall leave a smooth opening in the concrete surface. Burning off of rods, bolts or ties will not be permitted.

Any wire ties used shall be cut back at least one-half (1/2) inch from the face of the concrete.

Devices holding metal ties in place shall be capable of developing the strength of the tie and adjustable to allow for proper alignment.

Metal and wooden spreaders, which are separate from the forms, shall be removed entirely as the concrete is being placed.

Adequate clean-out openings shall be provided for narrow walls and other locations where access to the bottom of the forms is not readily attainable.

The facing of all forms shall be treated with bond breaking coating of such composition that would not discolor or otherwise injuriously affect the concrete surface. Care shall be exercised to prevent coating of the reinforcing steel.

(3) Metal Forms. The foregoing requirements for timber forms regarding design, mortar-tightness, filleted corners, beveled projections, bracing, alignment, removal, reuse and wetting shall also apply to metal forms, except that these will not require lining, unless specifically noted on the Plans.

The thickness of form metal shall be as required to maintain the true shape without warping or bulging. All bolt and rivet heads on the facing sides shall be countersunk. Clamps, pins or other connecting devices shall be designed to hold the forms rigidly together and to allow removal without injury to the concrete. Metal forms which do not present a smooth surface or which line up improperly shall not be used. Metal shall be kept free from rust, grease or other foreign materials.

(4) Form Supports for Overhang Slabs. Form supports which transmit a horizontal force to a steel girder or beam, or to a prestressed concrete beam will be permitted, providing a satisfactory structural analysis has been made of the effect on the girder or beam and approval is granted by the City.

When overhang brackets are used on prestressed concrete beam spans with slab overhangs not exceeding three (3) feet six (6) inches, bracing requirements shall conform to the details shown on the Plans.

For spans in which the overhang exceeds three feet six inches, additional support will be required for the outside beams regardless of the type beam used. Details of the proposed support system shall be submitted by the Contractor for approval.

Holes in steel members for support of overhang brackets may be punched or drilled full size or may be torch cut to one-fourth (1/4) inch under size and reamed full size. In no case shall the holes be burned full size. The hole shall be left open unless otherwise shown on the Plans. The holes shall never be filled by welding.

420.10. PLACING REINFORCEMENT.

Reinforcement shall be placed as provided in Item 440, "Reinforcing Steel". Reinforcing steel supports shall not be welded to I-beams or girders or to reinforcing steel except where shown on the Plans to be permissible.

Post tensioning ducts shall be placed in accordance with TxDOT Item 426, "Prestressing". The Contractor shall maintain all ducts free of obstructions until all post tensioning operations are complete.

420.11. PLACING CONCRETE-GENERAL.

The Contractor shall give the City sufficient advance notice before placing concrete in any unit of the structure to permit the inspection of forms, reinforcing steel placement and other preparations.

The sequence of placing concrete shall be as shown on the Plans or as required herein.

Concrete placement will not be permitted when impending weather conditions would impair the quality of the finished work. If conditions of wind, humidity, and temperature are such that concrete cannot be placed without cracking, concrete placement shall be done in the early morning or at night. When concrete mixing, placing, and finishing is done in other than daylight hours, provisions shall be made to adequately light the entire placement site. The City will approve the adequacy of such lighting before operations are begun.

Where work has been started and changes in weather conditions require protective measures, the Contractor shall furnish adequate shelter to protect the concrete against damage from rainfall, or from freezing temperatures as outlined in Section 420.12. If necessary to continue operations during rainfall, the Contractor shall also provide protective coverings for the material stockpiles. Aggregate stockpiles need to be covered only to the extent necessary to control the moisture conditions in the aggregates.

After concrete has achieved initial set, at least one (1) curing day shall elapse before placing strain on projecting reinforcement in order to prevent damage to the concrete**.**

(1) Placing Temperature. The temperature of all concrete at the time of placement shall be not less than 50° F.

The temperature of cast-in-place concrete in bridge slabs and top slabs of direct traffic structures shall not exceed 85° F when placed. Concrete diaphragms, parapets, concrete portions of railing, curbs, and sidewalks, unless monolithically placed with the slab, will not be subject to the above maximum. Other portions of structures, when shown on the Plans, shall require the temperature control specified.

For mass concrete placements, as defined in Section 420.11 (10), the concrete temperature at the time of placement shall not exceed 75° F.

(2) Transporting Time. The maximum time interval between the addition of cement to the batch and the placing of concrete in the forms shall conform to the requirements in Table 1.

TABLE 1
TEMPERATURE TIME REQUIREMENTS

Concrete Temperature (at point of placement)	Max. Time (No Retarding Agent) Minutes	Max. Time (1) (With Retarding Agent) Minutes
Non-Agitated Concrete		
Above 80ºF	15	30
80ºF and Below	30	45
Agitated Concrete		
Above 90ºF	45	75
Above 75ºF thru 90ºF	60	90
75ºF and Below	90	120

(1) Normal dosage of retarder

(3) Transporting Equipment. The method and equipment used to transport concrete to the forms shall be capable of maintaining the rate of placement shown on the Plans or required by the City. Concrete may be transported by buckets, chutes, buggies, belt conveyors, pumps, or other methods.

When belt conveyors or pumps are used, sampling for testing should be done at the discharge end. When in the opinion of the City, it is deemed impractical to sample at the discharge end, sampling may be done at the mixer provided that correlation testing is performed and documented to ensure specification requirements are met at the discharge end.

Concrete transported by conveyors shall be protected from sun and wind, if necessary, to prevent loss of slump and workability. Pipes through which concrete is pumped shall be shaded and/or wrapped with wet burlap, if necessary, to prevent loss of slump and workability. Concrete shall not be transported through aluminum pipes, tubes, or other aluminum equipment.

Pump lines shall conform to the following:

For Grade 2 coarse aggregate and smaller, the minimum size pump line shall be five (5) inches ID.

For Grade 1 coarse aggregate, the minimum size pump line shall be eight (8) inches ID.

Chutes, troughs, conveyors or pipes shall be arranged and used so that the concrete ingredients will not be separated. When necessary to prevent segregation, such equipment shall terminate in vertical downspouts. Open troughs and chutes shall extend, if necessary, down inside the forms or through holes left in the forms.

All transporting equipment shall be kept clean and free from hardened concrete coatings. Water used for cleaning shall be discharged clear of the concrete.

(4) Forms. Openings in forms shall be provided, if needed, for the removal of laitance or foreign matter.

All forms, prestressed concrete panels, T-beams, and concrete box beams on which concrete is to be placed shall be wetted thoroughly prior to placing concrete thereon. Any remaining puddles of excess water shall be removed. The top of such members shall be in moist surface dry condition when concrete is placed on them.

(5) Handling, Placing, and Consolidation. The method of handling, placing, and consolidation of concrete shall minimize segregation of the concrete and displacement of the reinforcement. A uniform dense compact mass shall be produced.

(a) Handling and Placing. Concrete shall not have a free fall of more than five (5) feet, except in the case of thin walls such as in culverts or as specified in other items. Any hardened concrete splatter ahead of the plastic concrete shall be removed.

Each part of the forms shall be filled by depositing concrete as near its final position as possible. Depositing large quantities at one (1) point and running or working the concrete along the forms will not be allowed.

Concrete shall be deposited in the forms in layers of suitable depth but not more than 36 inches in thickness, unless otherwise directed by the City.

Cold joints in a monolithic placement shall be avoided. The sequence of successive layers or adjacent portions of concrete shall be such that they can be vibrated into a homogeneous mass with the previously placed concrete. Not more than one (1) hour shall elapse between adjacent or successive placements of concrete except as otherwise required by an approved placing procedure when revibration of the concrete is shown on the Plans or specifications. This time requirement may be extended by one-half (1/2) hour when the concrete contains not less than a normal dosage of retarding admixture.

An approved retarding agent shall be used to control stress cracks and/or cold joints in placements where differential settlement and/or setting time may induce stress cracking.

(b) Consolidation. All concrete shall be well consolidated and the mortar flushed to the form surfaces with immersion type vibrators. Vibrators which operate by attachment to forms or reinforcement will not be permitted, except on steel forms. At least one (1) stand-by vibrator shall be provided for emergency use in addition to those required for placement.

The concrete shall be vibrated immediately after deposit. A systematic spacing of the points of vibration shall be established to insure complete consolidation and thorough working of the concrete around the reinforcement, embedded fixtures, and into the corners and angles of the forms. The vibrator may be inserted in a sloping or horizontal position in shallow slabs. The entire depth of each lift shall be vibrated, allowing the vibrator to penetrate several inches into the preceding lift. Concrete along construction joints shall be thoroughly consolidated by operating the vibrator along and close to but not against the joint surface. The vibration shall continue until thorough consolidation and complete embedment of reinforcement and fixtures is produced, but not long enough to cause segregation. Vibration may be supplemented by hand spading or rodding, if necessary, to insure the flushing of mortar to the surface of all forms.

(6) Slabs. Unless otherwise shown on the Plans or other specifications, slab concrete shall be mixed in a plant located off the structure. Carting or wheeling concrete batches over completed slabs will not be permitted until the slabs have aged at least four (4) full curing days. For the remainder of the curing period, timber planking will be required for carting of the concrete. Carts shall be equipped with pneumatic tires. Curing operations shall not be interrupted for the purposed of wheeling concrete over finished slabs.

The storing of reinforcing or structural steel on completed roadway slabs generally shall be avoided and, when permitted, shall be limited to quantities and distribution that will not induce excessive stresses.

A longitudinal screed may be placed directly on previously placed concrete slabs for the purpose of checking and grading of an adjacent slab after the previously placed slab has aged not less than 24 hours. Actual screeding may be done after the previously placed slabs have aged at least 48 hours.

(7) Continuous Placements. For continuous placement of the deck on steel units, the initial set of the concrete shall be retarded sufficiently to insure that the concrete remains plastic in not less than three (3) spans immediately preceding the slab being placed. For simple spans, retardation shall be required only if necessary to complete finishing operations or as required by Section 420.13.

(8) Fogging and Interim Curing. From the time of initial strike off of the concrete until finishing is completed and required interim curing is in place, the unformed surfaces of slab concrete in bridge decks and top slabs of direct traffic culverts shall be fogged when necessary to replace water loss due to evaporation.

Fogging equipment shall be capable of applying water in a fine mist, not a spray. The fog shall be produced using equipment, which pumps water or water and air under high pressure through a suitable atomizing nozzle. The equipment shall be hand operated and sufficiently portable for use in the direction of any prevailing wind. It shall be adaptable for intermittent use as directed by the City to prevent excessive wetting of the concrete.

Interim curing will be required for slab concrete in bridge decks and top slabs of the direct traffic culverts, immediately upon completion of final finish. Type 1-D membrane curing compound (Resin Base Only) will be required. Water curing will be required in accordance with Section 420.20 and shall be commenced as soon as possible without damaging the surface finish.

(9) Installation of Dowels and Anchor Bolts. Dowels and anchor bolts may be cast-in-place or installed by grouting with grout, epoxy or epoxy mortar. Holes for grouting may be formed or drilled.

(a) General. Holes for anchor bolts shall accommodate the bolt embedment required by the Plans. Holes for dowels shall be a minimum of 12 inches deep unless otherwise shown on the Plans. When grout or epoxy mortar is used, the diameter of the hole shall be not less than twice the dowel or bolt diameter or more than the diameter plus 1 1/2 inches. When using epoxy, the hole diameter shall be one-sixteenth (1/16) inch to one-fourth (1/4) inch greater than the dowel or bolt diameter.

Holes shall be thoroughly cleaned of all loose material, oil, grease, or other bond breaking substance and blown clean with filtered compressed air. Holes shall be in a surface dry condition when epoxy type material is used. Holes shall be in a surface moist condition when Portland cement grout is used. The Contractor shall develop and demonstrate a procedure for cleaning and preparing the holes for installation of the dowels and anchor bolts that is satisfactory to the City. The void between the hole and dowel or bolt shall be completely filled with grouting material.

(b) Cast-in-Place or Grouted Systems. Portland cement grout, epoxy, epoxy mortar, or other prepackaged grouts as approved by the City may be used.

Portland cement grout shall conform to the pertinent provisions of Item 421, "Portland Cement Concrete". Epoxy

(Type V) and Epoxy Mortar (Type VIIII) shall conform to TxDOT Item 575, "Epoxy". Grout, epoxy or epoxy mortar may be used as the binding agent unless otherwise indicated on the Plans.

(c) Other Anchor Systems. These systems shall be in accordance with the Plans and approved by the City.

(10) Mass Placements. Unless otherwise shown on the Plans, for monolithic mass placements having a least dimension greater than five (5) feet, the Contractor shall develop a plan to assure that during the heat dissipation period, the temperature differential between the central core of the placement and the exposed concrete surface does not exceed 35°F.

A detailed plan, along with an analysis of the associated heat generation and dissipation (heat flow analysis) shall be submitted to the City for approval. No concrete shall be placed until this plan is approved.

This plan may include a combination of the following:

1. Selection of concrete ingredients to minimize heat of hydration.

2. Using ice or cooling concrete ingredients.

3. Controlling rate of concrete placement.

4. Using insulation to control heat loss.

5. Using supplemental heat to control heat loss.

6. Use of fly ash.

The Contractor shall furnish and install two sets of strip chart temperature recording devices or approved equivalent at locations designated by the City. These devices shall be accurate to within +/- 2°F within the range of 32°F to 212°F and shall be used to simultaneously measure the temperature of the concrete at the core and the surface.

420.12. PLACING CONCRETE IN COLD WEATHER.

The Contractor is responsible for the protection of concrete placed under any and all weather conditions. Permission given by the City for placing during cold weather will not relieve the Contractor of the responsibility for producing concrete equal in quality to that placed under normal conditions. Should concrete placed under such conditions prove unsatisfactory, it shall be removed and replaced.

Concrete may be placed only when the atmospheric temperature is greater than 35°F. Concrete shall not be placed in contact with any material coated with frost or having a temperature less than 32°F.

Aggregates shall be free from ice, frost and frozen lumps. When required, in order to produce the minimum specified concrete temperature, the aggregate and/or the water shall be heated uniformly, in accordance with the following:

The water temperature shall not exceed 180°F, nor shall the aggregate temperature exceed 150°F. The heating apparatus shall heat the mass of aggregate uniformly. The temperature of the mixture of aggregates and water shall be between 50°F and 85°F before introduction of the cement.

The Contractor shall provide and install recording thermometer(s) or other suitable temperature measuring device(s) to verify that all concrete is effectively protected as follows:

(a) The temperature of all unformed surfaces of bridge decks and top slabs of direct traffic culverts shall be maintained at 50°F or above for a period of 72 hours from time of placement and above 40°F for an additional 72 hours.

(b) The temperature at the surface of all concrete in bents, piers, culvert walls, retaining walls, parapets, wingwalls, bottom of slabs, and other similar formed concrete shall be maintained at 40°F or above for a period of 72 hours from time of placement.

(c) The temperature of all concrete, including the bottom slabs (footings) of culverts placed on or in the ground, shall be maintained above 32°F for a period of 72 hours from the time of placement.

Protection shall consist of providing additional covering, insulated forms or other means, and if necessary, supplementing such covering with artificial heating. Curing as specified under Section 420.20 shall be provided during this period until all requirements for curing have been satisfied.

When impending weather conditions indicate the possibility of the need for such temperature protection, all necessary heating and covering material shall be on hand and ready for use before permission is granted to begin placement.

Sufficient extra test specimens will be made and cured with the placement to ascertain the condition of the concrete as placed to form removal and acceptance.

420.13. PLACING CONCRETE IN HOT WEATHER.

Unless otherwise directed by the City, when the temperature of the air is above 85°F, an approved retarding agent will be required in all concrete used in superstructures and top slabs of direct traffic culverts.

420.14. PLACING CONCRETE IN WATER.

Concrete shall be deposited in water only when shown on the Plans or with the written permission of the City. The forms or cofferdams shall be sufficiently tight to prevent any water current passing through the space in which the concrete is being deposited. Pumping of water will not be permitted during the concrete placing, nor until it has set for at least 36 hours.

The concrete shall be placed with a tremie, or other approved method, and shall not be permitted to fall freely through the water nor shall the concrete be disturbed after being placed. The concrete surface shall be kept approximately level during placement.

The tremie shall consist of a watertight tube of a diameter which will permit adequate placement of the concrete, but not greater than 14 inches. The tremie shall be constructed so that the bottom can be sealed and opened after the tremie is in place and fully charged with concrete. The tremie shall be supported so that it can be easily moved horizontally to cover all the work area and vertically to control the concrete flow. The lower end of the tremie shall be submerged in the concrete at all times.

The placing operations shall be continuous until the work is complete.

Unless otherwise specified, all classes of concrete placed under water, except Class E and Class SS, shall be redesigned to contain an additional sack of cement per cubic yard more than the mix design being used. Pilot beam tests may be waived by the City for this redesign.

420.15. PLACING CONCRETE IN SUPERSTRUCTURE.

Unless otherwise shown on the Plans, simple span bridge slabs shall be placed without transverse construction joints by using either a mechanical longitudinal screed or a self propelled transverse finishing machine. For small placements or for unusual conditions, the City may waive the mechanical screed requirement and permit the use of manually operated screeding equipment. The screed shall be adequately supported on a header or rail system sufficiently stable to withstand the longitudinal or lateral thrust of the equipment. Unless otherwise shown on the Plans, temporary intermediate headers will be permitted for placements exceeding 50 feet in length for the longitudinal screed, provided the rate of placement is rapid enough to prevent a cold joint, and that these headers are designed for early removal to permit satisfactory consolidation and finish of the concrete at their locations.

Unless otherwise shown on the Plans, slabs on continuous units shall be placed in one (1) continuous operation without transverse construction joints using a mechanical longitudinal screed or a self propelled transverse finishing machine. For unusual conditions, such as widening, variable cross slopes or transitions, the City may waive the mechanical screed requirement and permit the use of manually operated screeding equipment. Rails for transverse finishing machines, which are supported from the beams or girders, shall be installed so that the supports may be removed without damage to the slab. Bond between removable supports and the concrete shall be prevented in a manner acceptable to the City. Rail support parts, which remain embedded in the slab, shall not project above the upper mat of reinforcing steel. Rail or screed supports attached to I-beams or girders shall be subject to the requirements of Section 420.3.

Unless otherwise shown on the Plans, for transverse screeding, the minimum rate of concrete placement shall be 30 linear feet of bridge deck per hour. The Contractor shall furnish personnel and equipment capable of placing, finishing and curing the slab at an acceptable rate to insure compliance with the specifications.

The profile gradeline may require adjustment, due to variation in beam camber and other factors, to obtain the required cover over the slab reinforcement. Beams shall be set in a sufficient number of spans so that when adjustment is necessary, the profile gradeline can be adjusted over suitable increments and the revised gradeline will produce a smooth riding surface.

One or more passes shall be made with the screed over the bridge deck segment prior to the placement of concrete thereon to insure proper operation and maintenance of grades and clearances.

Slab concrete shall be deposited between the exterior beam and the adjacent beam prior to placing concrete in the overhang portion of the slab.

For transverse screeding, concrete shall be placed in transverse strips. Additionally, on profile grades greater than 1-1/2 percent, placement shall begin at the lowest end.

For longitudinal screeding, concrete shall be placed in longitudinal strips starting at a point in the center of the segment adjacent to one (1) side, except as provided herein, and the strip completed by placing uniformly in both directions toward the ends, except that for spans on a grade of 1-1/2 percent or more placing shall start at the lowest end.

The width of strips shall be such that the concrete therein will remain plastic until the adjacent strip is placed. Where monolithic curb construction is specified, the concrete shall be placed therein in proper sequence to be monolithic with the adjacent longitudinal strips of the slabs.

An approved system of checking shall be used to detect any vertical movement of the forms or falsework. Forms for the bottom surface of concrete slabs, girders and overhangs shall be maintained to the required vertical alignment during concrete placing.

Unless otherwise shown on the Plans, girders, slab and curbs of slab and girder spans shall be placed monolithically. Concrete girder stems shall be filled first and the slab concrete placed within the time limits specified in Section 420.11.

Construction joints, when permitted for slab placements on steel and prestressed concrete beams, shall be as shown on the Plans. Where Plans permit segmental placing without specifying a particular order of placement, any logical placing sequence which will not result in the overstressing of any of the supporting members will be permitted subject to the approval of the City.

Any falsework under steel girder or truss spans shall be released and the spans swung free on their permanent supports before placing any slab concrete thereon.

When the curb forms are filled, the top of curb and sidewalk section shall be brought to the correct camber and alignment and finished as described in Sections 420.18 and 420.23.

420.16. PLACING CONCRETE IN BOX CULVERTS.

Where the top slab and walls are placed monolithically in culverts more than four feet in clear height, an interval of not less than one (1) or more than two (2) hours shall elapse before placing the top slab to allow for settlement and shrinkage in the wall concrete.

The footing slab shall be accurately finished at the proper time to provide a smooth uniform surface. Top slabs, which carry direct traffic, shall be finished as specified in Section 420.19. Top slabs of fill-type culverts shall be given a float finish.

420.17. PLACING CONCRETE IN FOUNDATION AND SUBSTRUCTURE.

Concrete shall not be placed in footings until the depth and character of the foundation has been inspected by the City and permission has been given to proceed.

Placing of concrete footings upon seal concrete will be permitted after the cofferdams are free from water and the seal concrete cleaned. Any necessary pumping or bailing during the concreting operation shall be done from a suitable sump located outside the forms.

All temporary wales or braces inside the cofferdams shall be constructed or adjusted as the work proceeds to prevent unauthorized construction joints.

When footings can be placed in a dry excavation without the use of cofferdams, forms may be omitted, if approved by the City, and the entire excavation filled with concrete to the elevation of

the top of footing. In this case, measurement for payment will be based on the footing dimensions shown on the Plans.

Concrete in columns shall be placed monolithically between construction joints unless otherwise provided. Columns and caps and/or tie beams supported thereon may be placed in the same operation. To allow for settlement and shrinkage of the column concrete, it shall be placed to the lower level of the cap or tie beam and placement delayed for not less than one (1) hour nor more than two (2) before proceeding.

420.18. TREATMENT AND FINISHING OF HORIZONTAL SURFACES EXCEPT ROADWAY SLABS.

All unformed upper surfaces shall be struck off to grade and finished. The use of mortar topping for surfaces under this classification will not be permitted.

After the concrete has been struck off, the surface shall be floated with a suitable float. Bridge sidewalks shall be given a wood float or broom finish or may be striped with a brush, as specified by the City.

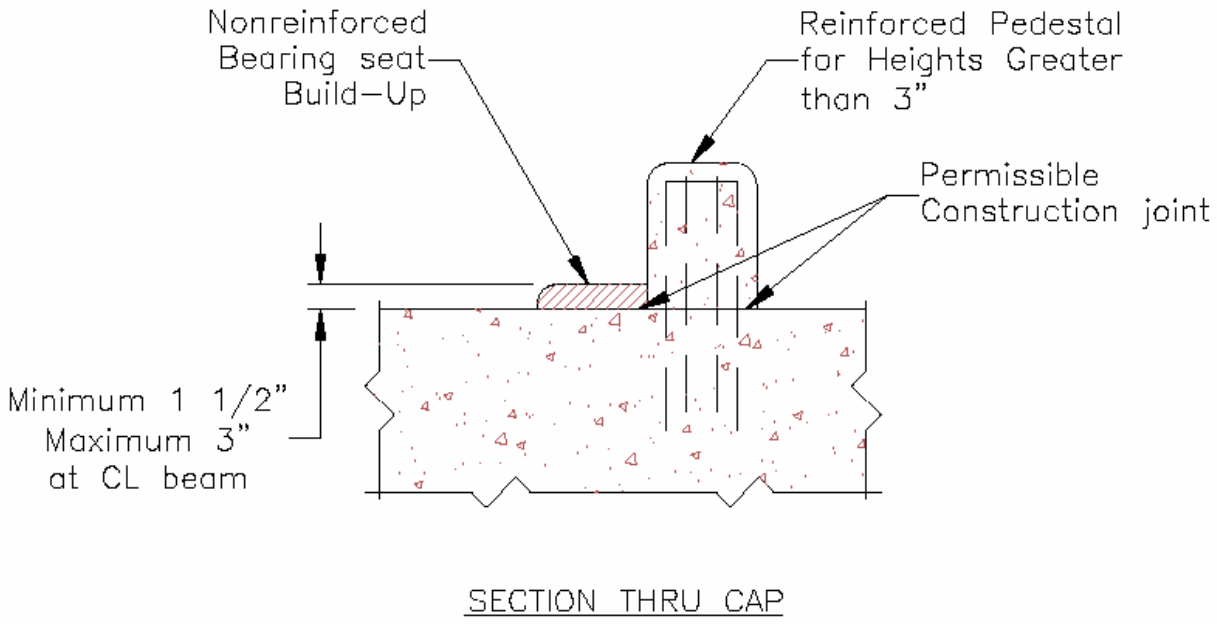
The tops of caps and piers between bearing areas shall be sloped slightly from the center toward the edge, and the tops of abutments and transition bents sloped from the backwall to the edge, as directed by the City, so that the water drains from the surface. The concrete shall be given a smooth trowel finish. When shown on the Plans, the top of caps and piers shall be coated with Type X epoxy material except for areas under shoes and bearing pads. Unless otherwise shown on the Plans, the color shall be concrete gray. The color of the epoxy may be adjusted to concrete gray by the use of a black universal type tinting paste. Bearing areas for steel units shall be constructed in accordance with TxDOT Item 441, “Steel Structures”.

Bearing seat build-ups or pedestals for concrete units may be cast integrally with the cap or with a construction joint as follows:

The bearing seat build-ups shall be constructed of a latex-based mortar or an epoxy mortar, mixed in accordance with the manufacturer's recommendation. Pedestals shall be constructed of Class “C” concrete, reinforced as shown on the Plans.

Bearing areas under elastomeric pads or non-reinforced bearing seat build-ups shall be given a textured, wood float finish.

FIGURE 1



420.19. FINISH OF ROADWAY SLABS.

In all roadway slab-finishing operations, camber for specified vertical curvature and transverse slopes shall be provided.

For concrete slab or concrete slab girder spans cast in place on falsework, an additional amount of camber shall be provided to offset the initial and final deflections of the span. The additional amount of camber shall be determined from the dead load deflection diagram shown on the Plans. When dead load deflection is not shown on the Plans, the additional amount of camber shall be one-eighth (1/8) inch per ten (10) foot of span length but not to exceed one-half (1/2) inch. For pan girder spans, the additional camber for initial and final deflections shall be approximately one-half (1/2) inch for 30-foot spans and five-eighths (5/8) inch for 40-foot spans unless otherwise directed by the City.

Roadway slabs supported on prestressed concrete, steel beams or girders shall receive no additional camber, except that for slabs without vertical curvature, the longitudinal camber shall be approximately one-fourth (1/4) inch.

Dead load deflection shall be taken into account in setting the grades of headers and rail systems.

Work bridges or other suitable facilities shall be provided by the Contractor from which to perform all finishing operations and check measurements for slab thickness and reinforcement cover.

As soon as the concrete has been placed and vibrated in a section of sufficient width to permit working, the surface shall be approximately leveled, struck off and screeded, carrying a slight

excess of concrete ahead of the screed to insure filling of all low spots. The screed shall be rigid enough to hold true to shape and shall have sufficient adjustments to provide for the required camber or section. A vibrating screed may be used if heavy enough to prevent undue distortion. The screeds, except those of the roller drum type, shall be provided with metal cutting edges.

Longitudinal screeds shall be moved across the concrete with a saw-like motion while their ends rest on headers or templates set true to the roadway grade or on the adjacent finished slab.

The surface of the concrete shall be screeded a sufficient number of times and at such intervals to produce a uniform surface, true to grade and free of voids.

If necessary, the screeded surface shall be worked to a smooth finish with a long handled wood or metal float, or hand floated from bridges over the slab.

When required by the City, the Contractor shall perform sufficient checks with a long handled ten 10 foot straightedge on the plastic concrete to insure that the final surface will be within the tolerances specified below. The check shall be made with the straightedge parallel to the centerline. Each pass thereof shall lap half of the preceding pass. All high spots shall be removed and all depressions over one-sixteenth (1/16) inch in depth shall be filled with fresh concrete and floated. The checking and floating shall be continued until the surface is true to grade and free of depressions, high spots, voids or rough spots.

Rail support holes shall be filled with concrete and finished to match the top of the slab.

Unless otherwise shown on the Plans, when no additional wearing course is to be placed, the bridge deck surface shall be given a grooved steel tine finish. The grooves shall be approximately one-eighth (1/8) to three-sixteenth (3/16)-inch deep, approximately one-eighth (1/8) inch wide. The tines shall be randomly spaced approximately three-fourths (3/4) to one (1) inch apart. The grooves shall run perpendicular to the structure centerline when a longitudinal screed is used. Areas, which receive insufficient texture depth, shall receive additional texturing, when directed by the City, by saw grooving in accordance with the procedure given below.

At the option of the Contractor, or when shown on the Plans, the surface shall be given its final texture by saw grooving to meet the above requirements. Saw grooving may be done a minimum of four days after the slab concrete has been placed. If saw grooving is done prior to the completion of curing, the curing shall be continued after sawing to provide the minimum curing time required.

When shown on the Plans that a concrete overlay is to be placed on the slab (new construction), or on prestressed concrete box beams or other precast elements, the slab or the top surface of shear key and diaphragm concrete shall be given a broom finish. The finish shall have an average texture depth of approximately 0.035 inches with any individual test, not falling below 0.020 inches unless otherwise shown on the Plans, when tested in accordance with Test Method Tex-436-A. Should the texture depth fall below that intended, the finishing procedures should be revised to produce the desired texture.

When the Plans require that an asphaltic seal, with or without overlay, on the slab (new construction), or on prestressed concrete box beams or other precast elements, the slab or top surface of shear key and diaphragm concrete shall be given a lightly textured broom finish having

an average texture depth of approximately 0.025 inches when tested in accordance with Test Method Tex-436-A.

Straightedge requirements will be required on slabs (new construction) to be overlaid.

After the concrete slab has attained final set, the City may require that the finished surface be tested with a standard ten (10) foot straightedge. The straightedge shall be used parallel to the centerline of the structure to bridge any depressions and touch high spots. Ordinates of the irregularities, measured from the face of the straightedge to the surface of the slab, should normally not exceed one-eighth (1/8) of an inch, making proper allowances for camber. Vertical curve and surface texture; however, occasional variations exceeding this will be acceptable if, in the opinion of the City, the variations will not produce unacceptable riding qualities.

When directed by the City, irregularities exceeding the above shall be corrected. Areas that are corrected to produce satisfactory riding qualities shall be provided with an acceptable surface texture in a manner approved by the City.

420.20. CURING CONCRETE.

The Contractor shall inform the City of the methods proposed for curing; shall provide the proper equipment and material in adequate amounts; and shall have the proposed methods, equipment and material approved prior to placing concrete.

Unless otherwise noted herein or shown on the Plans, the choice of curing methods shall be at the option of the Contractor, except that the City may require the same curing methods for like portions of a single structure.

Inadequate curing and/or facilities shall be cause for the City to delay all concrete placement on the job until remedial action is taken.

All concrete shall be cured for a period of four curing days except as noted herein.

TABLE 2
EXCEPTION TO 4 DAY CURING

Description	Type of cement	Required Curing Days
Upper Surfaces of bridge slabs, top slab of direct traffic culverts, and concrete overlays	I or III	8
	III or I/III*	10
	All types with fly ash	10
Concrete Piling Build-ups	All	6

*Meets the requirements of both Type I and Type III

When the air temperature is expected to drop below 40°F, the concrete shall be covered with polyethylene sheeting, burlap-polyethylene blankets, mats or other acceptable materials to provide the protection required by Section 420.12.

A curing day is defined as a calendar day when the temperature, taken in the shade away from artificial heat, is above 50°F for at least 19 hours, or on colder days if satisfactory provisions are made to maintain the temperature of all surfaces of the concrete above 40°F for the entire 24 hours. The required curing period shall begin when all concrete therein has attained its initial set.

The following methods are permitted for curing concrete subject to the requirements of Table 3 and the following additional requirements for each method of curing:

(1) Form Curing. When forms are left in contact with the concrete, other curing methods will not be required except for exposed surfaces and for cold weather protection.

(2) Water Curing. All exposed surfaces of the concrete shall be kept wet continuously for the required curing time. The water used for curing shall meet the requirements for concrete mixing water as specified in Item 421, "Portland Cement Concrete". Seawater will not be permitted. Water, which stains or leaves an unsightly residue, shall not be used.

(a) Wet Mat Curing. This curing method shall consist of keeping the concrete continuously wet by maintaining wet cotton mats in direct contact with the concrete for the required curing time. Damp burlap blankets made from nine (9) ounce stock may be placed on the damp concrete surface for temporary protection prior to the application of cotton mats. The cotton mats may then be placed dry and wetted down immediately after they are placed. The mats shall be weighted down adequately to provide continuous contact with all concrete where possible. Surface, which cannot be cured by direct contact, shall be covered with mats forming an enclosure well anchored to the forms or ground so that outside air cannot enter the enclosure. Sufficient moisture shall be provided inside the enclosure to keep all surfaces of the concrete wet. Wet mat curing will be required for Part A in Table 3 when the anticipated ambient temperature is expected to remain above 40^{o} F for the first 72 hours of the curing period.

Polyethylene sheeting, burlap-polyethylene blankets, laminated mats or insulating curing mats placed in direct contact with the slab will be required when the air temperature is expected to drop below 40°F during the first 72 hours of the curing period. These curing materials shall be weighted down with dry mats to maintain direct contact with the concrete and to provide insulation against cold weather. Supplemental heating or insulation may be required in cold and/or wet weather if the insulating cotton mats become wet or if the concrete drops below the specified curing temperature.

(b) Water Spray. This curing method shall consist of overlapping sprays or sprinklers that keep all unformed surfaces continuously wet.

(c) Ponding. This curing method requires the covering of the surfaces with a minimum of two inches of clean granular material, kept wet at all times, or a minimum of one (1) inch depth of water. Satisfactory provisions shall be made to provide a dam to retain the water or saturated granular material.

(3) Membrane Curing. Unless otherwise provided herein or shown on the Plans, either Type 1-D or Type 2, membrane curing compound may be used where membrane curing is permitted, except that Type 1-D (Resin Base Only), will be required for bridge slabs and top slabs of direct traffic culverts. All other surfaces which may require a higher grade of surface finish.

TABLE 3
CURING REQUIREMENTS

STRUCTURE UNIT DESCRIPTION	REQUIRED		PERMITTED	
	Water for Complete Curing	Membrane for Interim Curing	Water for Complete Curing	Membrane for Interim Curing
A. Upper surfaces of Bridge Roadway, Median and Sidewalk slabs of Direct Traffic Culverts	X	X (Resin Base)		
B. Top Surface of any Concrete Unit upon which Concrete is to be placed and bonded at a later interval (Stub Walls, Risers, etc.).	X			
C. All Substructure Concrete, Culverts, Box Sewers, Inlets, Manholes, Retaining Walls, Riprap, Railing			*X	*X
All other concrete	As specified in other items.			

*Polyethylene Sheeting, Burlap-Polyethylene Mats or Laminated Mats in close intimate contact with the concrete surfaces will be considered equivalent to water or membrane curing.

For substructure concrete only one type of curing compound will be permitted on any one structure. Material requirements and construction methods shall be as required by TxDOT Item 526, "Membrane Curing", except as changed herein.

Membrane curing shall not be applied to dry surfaces, but shall be applied just after free moisture has disappeared. Formed surfaces and surfaces, which have been given a first rub, shall be dampened and shall be moist at the time of application of the membrane.

When membrane is used for complete curing, the film shall remain unbroken for the minimum curing period specified. Membrane, which is damaged, shall be corrected immediately by reapplication of membrane. Unless otherwise noted herein or shown on the Plans, the choice of membrane type shall be at the option of the Contractor.

420.21. REMOVAL OF FORMS AND FALSEWORK.

Except as herein provided, forms for vertical surfaces may be removed when the concrete has aged not less than 12 hours, provided the removal can be done without damage to the concrete.

Forms for inside curb faces may be removed at such time the removal can be done without damage to the curb.

Weight supporting forms and falsework for all bridge components and culvert slabs, except as noted herein, shall remain in place a minimum of four curing days. The forms then may be removed if the concrete has attained a flexural strength of 425 psi, as evidenced by strength tests using test beams made from the same concrete and cured under the same conditions as the portion of the structure involved. Forms for other structural components may be removed as specified by the City.

Inside forms (walls and top slabs) for box culverts and sewers may be removed after concrete has aged not less than one day (24 hrs.) and has acquired a flexural strength of not less than 255 psi, provided an overhead support system, approved by the City, is used to transfer the weight of the top slab to the walls of the box culvert or sewer before the support provided by the forms is removed.

When all test beams made for the purpose of form removal have been broken without attaining the required strength, forms shall remain in place for a total of 14 curing days.

The above provisions relative to form removal shall apply only to forms or parts thereof which are constructed to permit removal without disturbing forms or falsework required to be left in place for a longer period on other portions of the structure.

All forms and falsework shall be removed unless otherwise approved by the City.

420.22. DEFECTIVE WORK.

Any defective work shall be repaired as soon as possible.

Any defect, which in the opinion of the City cannot be repaired satisfactorily to the extent required by the City, shall be removed and replaced at the expense of the Contractor.

420.23. FINISHING EXPOSED SURFACES.

A Surface Finish shall be applied to all concrete surfaces and shall be in accordance with TxDOT Item 427, “Surface Finishes for Concrete”.

420.24. MEASUREMENT.

The quantities of concrete of the various classifications which will constitute the completed and accepted structure or structures in place will be measured by the cubic yard, each, square foot, square yard, or linear foot as shown on the Plans. Measurement will be as follows:

(1) General.

(a) All concrete quantities will be placed on the dimensions shown on the Plans or those established in writing by the City. Diaphragm concrete, when required, will be included in the slab measurement.

(b) In all determining quantities, no deductions will be made for chamfers less than two (2) inches, embedded portions of structural steel or prestressed concrete beams, piling, anchor bolts, reinforcing steel, drains, weep holes, junction boxes, electrical or telephone conduit, conduit and/or voids for prestressed tendons or for embedded portions of light fixtures.

(c) For pan girder spans, a quantity will be included for the screed setting required providing proper camber in the roadway surface after form removal.

(d) For slabs on steel and prestressed beams, a quantity for the haunch between the slab and beams will be included when required. No measurement will be made during construction for variation in the amount of haunch concrete due to deviation from design camber in the beams.

(e) For slabs on panels, T-beams, or box beams, the combination of span length, theoretical camber in beams, computed deflections, and plan vertical curve will be taken into account in determining the quantity for the slab.

Additional concrete, which may be required by an adjustment of the profile grade line during construction, to insure proper slab thickness, will not be measured for payment.

(f) Variation in concrete headwall quantity incurred when an alternate bid for pipe is permitted will not be measured for payment.

(g) Quantities revised by a change in design, measured as specified herein, will be increased or decreased, as the case may be, and included for payment.

(2) Plan Quantity. For structure elements designated in Table 4, and when measured by the cubic yard, this is a Plans quantity measurement Item and the quantity to be paid for will be that quantity shown in the proposal and on the "Estimate and Quantity" sheet of the contract Plans. If no adjustment of quantities is required, additional measurements or calculations will not be required.

When the quantity for a complete structure element has been erroneously included or omitted from the Plans, the quantity shown on the Plans for that element will be added to or deducted from the plan quantity and included for payment. A complete structure element will be the smallest portion of a total structure for which a quantity is included on the Plans.

When the plan quantity for a complete structure element is in error by five (5) percent or more, a recalculation will be made and the corrected quantity included for payment.

(3) Measured in Place. For those items not measured for plan quantity payment, measurement will be made in place.

TABLE 4

PLAN QUANTITY PAYMENT
(CUBIC YARD MEASUREMENT ONLY)

Culverts and Wingwalls	Slabs on Steel Spans
Headwalls for pipe	Slabs on Prestressed Spans
Retaining Walls	Pan Girder Spans
Inlets and Manholes	Pile Bent Caps
Slab Spans	Shear Key Concrete
Slab and Girder Spans	Abutments

Note: Other structure elements may be paid for as "plan quantity", including pier and bent concrete, when shown on the Plans.

For those portions of structures not listed in Table 4, the concrete quantities, measured as provided in Sub Section 420.24.(1) will be paid for at the unit price bid per "Cubic Yard", per "Each", per "Square Foot", per "Square Yard", or per "Linear Foot", in place, for the various classifications of concrete shown.

420.25. PAYMENT.

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for the various structure elements specified of the various classes of concrete. This price shall be full compensation for furnishing, hauling and mixing all concrete materials; for furnishing, bending, fabricating, splicing, welding and placing the required reinforcement; for all clips, blocks, metal spacers, ties, wire or other materials used for fastening reinforcement in place; for placing, finishing and curing all concrete; for all grouting and pointing; for furnishing and placing drains; for furnishing and placing metal flashing strips; for furnishing and placing expansion-joint material required by this Item; and for all forms and falsework, labor, tools, equipment and incidentals necessary to complete the work.

Concrete which fails to meet minimum strength requirements may be rejected or a structural review may be made by the City. Such concrete which is proven structurally adequate may be accepted at an adjusted price based on the following formula:

$$\mathbf{A = 0.10 \times Bp + 0.75 \times (Sa/Ss)^2 \times Bp}$$

Where:

A = Amount to be paid per unit of measure

Bp = Unit bid price

Sa = Actual strength from beams or cores (average value if more than one test taken)

Ss = Minimum required strength (specified)

CITY OF SAN ANGELO

ITEM 529

CONCRETE CURB, GUTTER AND COMBINED CURB AND GUTTER

529.1. DESCRIPTION.

This Item shall govern for construction of concrete curb, gutter and combined curb and gutter, with or without reinforcing steel, composed of Portland Cement concrete on approved subgrade, foundation material or finished surface in accordance with the lines and grades established by the City and in conformance with the details shown on the Plans.

As used in this Item, the word "curb" refers to concrete curb, concrete gutter and combined concrete curb and gutter.

529.2. MATERIALS.

All materials shall conform to the pertinent requirements of the following Item:

Item 421, "Portland Cement Concrete"

Concrete used in conventionally formed and slipformed construction shall be Class "A" concrete or concrete as specified for concrete pavement. Unless otherwise shown on the Plans, concrete for extruded construction shall be Class "A", except that the coarse aggregates shall meet the requirements of Grade 8. Other grades of coarse aggregate may be substituted, if approved by the City.

529.3. CONSTRUCTION METHODS.

(1) Conventionally Formed Concrete. Prior to curb construction, the subgrade, foundation or pavement surface shall be shaped to the line, grade and cross section shown on the Plans and, if considered necessary by the City, hand tamped and sprinkled. When directed by the City, the subgrade or foundation material shall be sprinkled. When directed by the City, the subgrade or foundation material shall be sprinkled lightly immediately before concrete is deposited thereon.

Forms shall be of wood, metal or other approved material, of a section satisfactory to the City, straight, free of warp and of the depth required. They shall be securely staked to line and grade, and maintained in a true position during the placing of concrete.

The reinforcing steel, if required, shall be placed as shown on the Plans. Care shall be exercised to keep all steel in its proper location during concrete placement.

Unless other methods are shown on the Plans or approved by the City, the concrete shall be placed into the forms and then struck off with a template, which is approximately 1/4" to 3/8" less than the dimension of the finished curb. After the concrete has been struck off and after it has become sufficiently set, the surface shall be plastered with a mortar consisting of one part of Portland

Cement and two (2) parts fine aggregate. The mortar shall be applied with a template made to conform to the finished curb dimensions as shown on the Plans. Exposed edges shall be rounded by the use of an edging tool to the radius shown on the Plans. All exposed surfaces shall be brushed to a smooth and uniform surface.

Curbs, gutters and combined curb and gutters shall be placed in sections of 50-foot maximum length unless otherwise approved by the City.

Joints shall be of the type and spacing shown on the Plans. Preferably on ten (10) foot spaces if not shown on Plans.

Hand finishing will be permitted.

The completed work shall be cured with an approved curing compound.

(2) Extruded or Slipformed Concrete. The concrete shall be placed with self-propelled equipment approved by the City. When placement is directly on subgrade or foundation materials, the foundation shall be hand-tamped and sprinkled if considered necessary by the City. If the concrete is placed directly on the surface material or pavement, such surface shall be thoroughly cleaned. If required by Plan details, the cleaned surface shall then be coated with an approved adhesive or other coating as specified at the rate of application shown.

The reinforcing steel, if required, shall be placed as shown on the Plans. Care shall be exercised to keep all steel in its proper location during concrete placement.

The line shall be maintained from a guideline set by the Contractor based on the alignment data shown on the Plans. The outline shall strictly conform to the details shown on the Plans. The forming tube of the extrusion machine or the form of the slipform machine shall be readily adjustable vertically during the forward motion of the machine to provide required variable heights necessary to conform to the established grade line. To provide a continual check on the grade, a pointer or gauge shall be attached to the machine in such a manner that a comparison can be made between the extruded or slipform work and the guideline. Other methods may be used, if approved in writing by the City.

Concrete shall be fed into the machine in such a manner and at such consistency that the finished work will present a well-compacted mass with a surface free from voids and honeycomb, and true to the required shape, line and grade.

Any additional surface finishing specified and/or required shall be performed immediately after extrusion or slipforming. Expansion joints shall be at the beginning and ending of radius and every 100' between radii.

Hand finishing will be permitted.

All exposed surfaces shall be cured with an approved curing compound.

529.4. MEASUREMENT.

This Item will be measured by the linear foot, complete in place.

529.5. PAYMENT.

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Concrete Curb", "Concrete Gutter" or "Concrete Curb and Gutter" of the type specified. This price shall be full compensation for furnishing all materials required; for surface preparation of base; and for all manipulations, labor, tools, equipment, and incidentals necessary to complete the work.

PART III–TEXAS DEPARTMENT OF TRANSPORTATION SPECIFICATIONS FOR CONSTRUCTION AND MAINTENANCE OF HIGHWAYS, STREETS, AND BRIDGES

Item 105

Removing Treated and Untreated Base and Asphalt Pavement

1. DESCRIPTION

Break, remove, and store or dispose of existing asphalt pavement, including surface treatments, and treated or untreated base materials.

2. CONSTRUCTION

Break material retained by the Department into pieces not larger than 24 in. unless otherwise shown on the plans. Remove existing asphalt pavement before disturbing stabilized base. Avoid contamination of the asphalt materials and damage to adjacent areas. Repair material damaged by operations outside the designated locations.

Stockpile materials designated salvageable at designated sites when shown on the plans or as directed. Prepare stockpile site by removing vegetation and trash and by providing for proper drainage. Material not designated to be salvaged will become the property of the Contractor. When this material is disposed of, do so in accordance with federal, state, and local regulations.

3. MEASUREMENT

This Item will be measured by the 100-ft. station along the baseline of each roadbed, by the square yard of existing treated or untreated base and asphalt pavement in its original position, or by the cubic yard of existing treated or untreated base and asphalt pavement in its original position, as calculated by the average end area method. Square yard and cubic yard measurement will be established by the widths and depths shown on the plans and the lengths measured in the field.

4. PAYMENT

The work performed in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “Removing Treated and Untreated Base and Asphalt Pavement” of the depth specified. This price is full compensation for breaking the material, loading, hauling, unloading, stockpiling or disposing; repair to areas outside designated locations for removal; and equipment, labor, tools, and incidentals.

Item 432
Riprap

1. DESCRIPTION

Furnish and place concrete, stone, cement-stabilized, or special riprap.

2. MATERIALS

Furnish materials in accordance with the following Items.

- Item 420, "Concrete Substructures,"
- Item 421, "Hydraulic Cement Concrete,"
- Item 431, "Pneumatically Placed Concrete,"
- Item 440, "Reinforcement for Concrete," and
- DMS-6200, "Filter Fabric."

2.1. **Concrete Riprap**. Use Class B Concrete unless otherwise shown on the plans.

2.2. **Pneumatically Placed Concrete Riprap**. Use Class II concrete that meets Item 431, "Pneumatically Placed Concrete," unless otherwise shown on the plans.

2.3. **Stone Riprap**. Use durable natural stone with a bulk specific gravity of at least 2.50 as determined by Tex-403-A unless otherwise shown on the plans. Provide stone that, when tested in accordance with Tex-411-A, has weight loss of no more than 18% after 5 cycles of magnesium sulfate solution.

Perform a size verification test on the first 5,000 sq. yd. of finished riprap stone for all types of stone riprap at a location determined by the Engineer. Test the riprap stone in accordance with ASTM D5519. Additional tests may be required. Do not place additional riprap until the initial 5,000 sq. yd. of riprap has been approved.

Provide grout or mortar in accordance with Item 421, "Hydraulic Cement Concrete," when specified. Provide grout with a consistency that will flow into and fill all voids.

Provide filter fabric in accordance with DMS-6200, "Filter Fabric." Provide Type 2 filter fabric for protection stone riprap unless otherwise shown on the plans. Provide Type 2 filter fabric for Type R, F, or Common stone riprap when shown on the plans.

2.3.1. **Type R**. Use stones between 50 and 250 lb. with at least 50% of the stones heavier than 100 lb.

2.3.2. **Type F**. Use stones between 50 and 250 lb. with at least 40% of the stones heavier than 100 lb. Use stones with at least 1 broad flat surface.

2.3.3. **Common**. Use stones between 50 and 250 lb. Use stones that are at least 3 in. in their least dimension. Use stones that are at least twice as wide as they are thick. When shown on the plans or approved, material may consist of broken concrete removed under the Contract or from other approved sources. Cut exposed reinforcement flush with all surfaces before placement of each piece of broken concrete.

2.3.4. **Protection**. Use boulders or quarried rock that meets the gradation requirements of Table 1. Both the width and the thickness of each piece of riprap must be at least 1/3 of the length. When shown on the plans or as approved, material may consist of broken concrete removed under the Contract or from other approved sources. Cut exposed reinforcement flush with all surfaces before placement of each piece of broken

concrete. Determine gradation of the finished, in-place, riprap stone under the direct supervision of the Engineer in accordance with ASTM D5519.

Table 1
In-Place Protection Riprap Gradation Requirements

Size	Maximum Size (lb.)	90% Size[1] (lb.)	50% Size[2] (lb.)	8% Size[3] Minimum (lb.)
12 in.	200	80–180	30–75	3
15 in.	320	170–300	60–165	20
18 in.	530	290–475	105–220	22
21 in.	800	460–720	175–300	25
24 in.	1,000	550–850	200–325	30
30 in.	2,600	1,150–2,250	400–900	40

1. Defined as that size such that 10% of the total riprap stone, by weight, is larger and 90% is smaller.
2. Defined as that size such that 50% of the total riprap stone, by weight, is larger and 50% is smaller.
3. Defined as that size such that 92% of the total riprap stone, by weight, is larger and 8% is smaller.

The Engineer may require in-place verification of the stone size. Determine the in-place size of the riprap stone by taking linear transects along the riprap and measuring the intermediate axis of the stone at select intervals. Place a tape measure along the riprap and determine the intermediate axis size of the stone at 2 ft. intervals. Measure a minimum of 100 stones, either in a single transect or in multiple transects, then follow ASTM D5519 Test Procedure Part B to determine the gradation. Table 2 is a guide for comparing the stone size in inches to the stone weight shown in Table 1.

Table 2
Protection Riprap Stone Size[1]

Size	Dmax (in.)	D90 (in.)	D50 (in.)	D8 (in.)
12 in.	13.76	10.14–13.29	7.31–9.92	3.39
15 in.	16.10	13.04–15.75	9.21–12.91	6.39
18 in.	19.04	15.58–18.36	11.10–14.21	6.59
21 in.	21.85	18.17–21.09	13.16–15.75	6.88
24 in.	23.53	19.28–22.29	13.76–16.18	7.31
30 in.	32.36	24.65–30.84	17.34–22.72	8.05

1. Based on a Specific Gravity of 2.5 and using the following equation for the intermediate axis diameter $D = \{(12*W)/(Gs*62.4*0.85)\}^{1/3}$

   where:
   D = intermediate axis diameter in in.;
   W = weight of stone in lbs.;
   Gs = Specific Gravity of stone.
   Note—If the Specific Gravity of the stone is different than 2.5, then the above equation can be used to determine the appropriate size using the actual Specific Gravity.

If required, provide bedding stone that, in-place, meets the gradation requirements shown in Table 3 or as otherwise shown on the plans. Determine the size distribution in Table 3 in accordance with ASTM D6913.

Table 3
Protection Riprap Bedding Material Gradation Requirements

Sieve Size (Sq. Mesh)	% by Weight Passing
3"	100
1-1/2"	50–80
3/4"	20–60
#4	0–15
#10	0–5

2.4. **Cement-Stabilized Riprap**. Provide aggregate that meets Item 247, “Flexible Base,” for the type and grade shown on the plans. Use cement-stabilized riprap with 7% hydraulic cement by dry weight of the aggregate.

2.5. **Special Riprap**. Furnish materials for special riprap according to the plans.

3. CONSTRUCTION

Dress slopes and protected areas to the line and grade shown on the plans before the placement of riprap. Place riprap and toe walls according to details and dimensions shown on the plans or as directed.

3.1. **Concrete Riprap**. Reinforce concrete riprap with 6 × 6 – W2.9 × W2.9 welded wire fabric or with No. 3 or No. 4 reinforcing bars spaced at a maximum of 18 in. in each direction unless otherwise shown. Alternative styles of welded wire fabric that provide at least 0.058 sq. in. of steel per foot in both directions may be used if approved. A combination of welded wire fabric and reinforcing bars may be provided when both are permitted. Provide a minimum 6-in. lap at all splices. Provide horizontal cover of at least 1 in. and no more than 3 in. at the edge of the riprap. Place the first parallel bar no more than 6 in. from the edge of concrete. Use approved supports to hold the reinforcement approximately equidistant from the top and bottom surface of the slab. Adjust reinforcement during concrete placement to maintain correct position.

Sprinkle or sprinkle and consolidate the subgrade before the concrete is placed as directed. All surfaces must be moist when concrete is placed.

Compact and shape the concrete once it has been placed to conform to the dimensions shown on the plans. Finish the surface with a wood float after it has set sufficiently to avoid slumping to secure a smooth surface or broom finish as approved.

Cure the riprap immediately after the finishing operation according to Item 420, “Concrete Substructures.”

3.2. **Stone Riprap**. Provide the following types of stone riprap when shown on the plans:

- **Dry Riprap**. Stone riprap with voids filled with only spalls or small stones.
- **Grouted Riprap**. Type R, F, or Common stone riprap with voids grouted after all the stones are in place.
- **Mortared Riprap**. Type F stone riprap laid and mortared as each stone is placed.

Use spalls and small stones lighter than 25 lb. to fill open joints and voids in stone riprap, and place to a tight fit.

Place mortar or grout only when the air temperature is above 35°F. Protect work from rapid drying for at least 3 days after placement.

Place filter fabric with the length running up and down the slope unless otherwise approved. Ensure fabric has a minimum overlap of 2 ft. Secure fabric with nails or pins. Use nails at least 2 in. long with washers or U-shaped pins with legs at least 9 in. long. Space nails or pins at a maximum of 10 ft. in each direction and 5 ft. along the seams. Alternative anchorage and spacing may be used when approved.

3.2.1. **Type R**. Construct riprap as shown in Figure 1 on the *Stone Riprap Standard* and as shown on the plans. Place stones in a single layer with close joints so most of their weight is carried by the earth and not the adjacent stones. Place the upright axis of the stones at an angle of approximately 90° to the embankment slope. Place each course from the bottom of the embankment upward with the larger stones in the lower courses.

Fill open joints between stones with spalls. Place stones to create a uniform finished top surface. Do not exceed a 6-in. variation between the tops of adjacent stones. Replace, embed deeper, or chip away stones that project more than the allowable amount above the finished surface.

Prevent earth, sand, or foreign material from filling the spaces between the stones when the plans require Type R stone riprap to be grouted. Wet the stones thoroughly after they are in place, fill the spaces between the stones with grout, and pack. Sweep the surface of the riprap with a stiff broom after grouting.

3.2.2. **Type F**.

3.2.2.1. **Dry Placement**. Construct riprap as shown in Figure 2 on the *Stone Riprap Standard*. Set the flat surface on a prepared horizontal earth bed, and overlap the underlying course to secure a lapped surface. Place the large stones first, roughly arranged in close contact. Fill the spaces between the large stones with suitably sized stones placed to leave the surface evenly stepped and conforming to the contour required. Place stone to drain water down the face of the slope.

3.2.2.2. **Grouting**. Construct riprap as shown in Figure 3 on the *Stone Riprap Standard*. Size, shape, and lay large flat-surfaced stones to produce an even surface with minimal voids. Place stones with the flat surface facing upward parallel to the slope. Place the largest stones near the base of the slope. Fill spaces between the larger stones with stones of suitable size, leaving the surface smooth, tight, and conforming to the contour required. Place the stones to create a plane surface with a variation no more than 6 in. in 10 ft. from true plane. Provide the same degree of accuracy for warped and curved surfaces. Prevent earth, sand, or foreign material from filling the spaces between the stones. Wet the stones thoroughly after they are in place, fill the spaces between them with grout, and pack. Sweep the surface with a stiff broom after grouting.

3.2.2.3. **Mortaring**. Construct riprap as shown in Figure 2 on the *Stone Riprap Standard*. Lap courses as described for dry placement. Wet the stones thoroughly before placing mortar. Bed the larger stones in fresh mortar as they are being place and shove adjacent stones into contact with one another. Spread excess mortar forced out during placement of the stones uniformly over them to fill all voids completely. Point up all joints roughly either with flush joints or shallow, smooth-raked joints as directed.

3.2.3. **Common**. Construct riprap as shown in Figure 4 on the *Stone Riprap Standard*. Place stones on a bed excavated for the base course. Bed the base course of stone well into the ground with the edges in contact. Bed and place each succeeding course in even contact with the preceding course. Use spalls and small stones to fill any open joints and voids in the riprap. Ensure the finished surface presents an even, tight surface, true to the line and grades of the typical sections.

Prevent earth, sand, or foreign material from filling the spaces between the stones when the plans require grouting common stone riprap. Wet the stones thoroughly after they are in place; fill the spaces between them with grout; and pack. Sweep the surface with a stiff broom after grouting.

3.2.4. **Protection**. Construct riprap as shown in Figure 5 on the *Stone Riprap Standard*. Place riprap stone on the slopes within the limits shown on the plans. Place stone for riprap on the filter fabric to produce a reasonably well-graded mass of riprap with the minimum practicable percentage of voids. Construct the riprap to the lines and grades shown on the plans or staked in the field. A tolerance of +6 in. and −0 in. from the slope line and grades shown on the plans is allowed in the finished surface of the riprap. Place riprap to its full thickness in a single operation. Avoid displacing the filter fabric. Ensure the entire mass of stones in their final position is free from objectionable pockets of small stones and clusters of larger stones. Do not place riprap in layers, and do not place it by dumping it into chutes, dumping it from the top of the slope, pushing it from the top of the slope, or any method likely to cause segregation of the various sizes. Obtain the desired distribution of the various sizes of stones throughout the mass by selective loading of material at the quarry or other source or by other methods of placement that will produce the specified results. Rearrange individual stones by mechanical equipment or by hand if necessary to obtain a reasonably well-graded distribution of stone sizes. Use the bedding thickness shown and place stone for riprap on the bedding material to produce a reasonably well-graded mass of riprap with the minimum practicable percentage of voids if required on the plans.

3.3. **Pneumatically Placed Concrete Riprap, Class II**. Meet Item 431, “Pneumatically Placed Concrete.” Provide reinforcement following the details on the plans and Item 440, “Reinforcement for Concrete.” Support reinforcement with approved supports throughout placement of concrete.

Give the surface a wood-float finish or a gun finish as directed. Cure the riprap with membrane-curing compound immediately after the finishing operation in accordance with Item 420, “Concrete Substructures.”

3.4. **Cement-Stabilized Riprap**. Follow the requirements of the plans and the provisions for concrete riprap except when reinforcement is not required. The Engineer will approve the design and mixing of the cement-stabilized riprap.

3.5. **Special Riprap**. Construct special riprap according to the plans.

4. MEASUREMENT

This Item will be measured by the cubic yard of material complete in place. Volume will be computed on the basis of the measured area in place and the thickness and toe wall width shown on the plans.

If required on the plans, the pay quantity of the bedding material for stone riprap for protection to be paid for will be measured by the cubic yard as computed from the measured area in place and the bedding thickness shown on the plans.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Riprap" of the type, thickness, and void-filling technique (Dry, Grout, Mortar) specified, as applicable. This price is full compensation for furnishing, hauling, and placing riprap and for filter fabric, expansion joint material, concrete and reinforcing steel, grout and mortar, scales, test weights, equipment, labor, tools, and incidentals.

Payment for excavation of toe wall trenches, for all necessary excavation below natural ground or bottom of excavated channel, and for shaping of slopes for riprap will be included in the unit price bid per cubic yard of riprap.

When bedding is required for protection stone riprap, payment will be made at the unit price for "Bedding Material" of the thickness specified. This price is full compensation for furnishing, hauling, placing, and maintaining the bedding material until placement of the riprap cover is completed and accepted; excavation required for placement of bedding material; and equipment, scales, test weights, labor, tools, and incidentals. No payment will be made for excess thickness of bedding nor for material required to replace embankment material lost by rain wash, wind erosion, or otherwise.

Item 464
Reinforced Concrete Pipe

1. DESCRIPTION

Furnish and install reinforced concrete pipe, materials for precast concrete pipe culverts, or precast concrete storm drain mains, laterals, stubs, and inlet leads.

2. MATERIALS

2.1. **Fabrication**. Fabrication plants must be approved by the Construction Division in accordance with DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification," before furnishing precast reinforced concrete pipe for Department projects. The Department's MPL has a list of approved reinforced concrete pipe plants.

Furnish material and fabricate reinforced concrete pipe in accordance with DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification."

2.2. **Design**.

2.2.1. **General**. The class and D-load equivalents are shown in Table 1. Furnish arch pipe in accordance with ASTM C506 and the dimensions shown in Table 2. Furnish horizontal elliptical pipe in accordance with ASTM C507 and the dimensions shown in Table 3. For arch pipe and horizontal elliptical pipe the minimum height of cover required is 1 ft.

Table 1
Circular Pipe
ASTM C76 & ASTM C655

Class	D-Load
I	800
II	1,000
III	1,350
IV	2,000
V	3,000

Table 2
Arch Pipe

Design Size	Equivalent Diameter (in.)	Rise (in.)	Span (in.)
1	18	13-1/2	22
2	21	15-1/2	26
3	24	18	28-1/2
4	30	22-1/2	36-1/4
5	36	26-5/8	43-3/4
6	42	31-5/16	51-1/8
7	48	36	58-1/2
8	54	40	65
9	60	45	73
10	72	54	88

Table 3
Horizontal Elliptical Pipe

Design Size	Equivalent Diameter (in.)	Rise (in.)	Span (in.)
1	18	14	23
2	24	19	30
3	27	22	34
4	30	24	38
5	33	27	42
6	36	29	45
7	39	32	49
8	42	34	53
9	48	38	60
10	54	43	68

2.2.2. **Jacking, Boring, or Tunneling**. Design pipe for jacking, boring, or tunneling considering the specific installation conditions such as the soil conditions, installation methods, anticipated deflection angles, and jacking stresses. Provide design notes and drawings signed and sealed by a Texas licensed professional engineer when requested.

2.3. **Marking**. Furnish each section of reinforced concrete pipe marked with the following information specified in DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification."

- class or D-load of pipe,
- ASTM designation,
- date of manufacture,
- pipe size,
- name or trademark of fabricator and plant location,
- designated fabricator's approval stamp,
- pipe to be used for jacking and boring (when applicable), and
- designation "SR" for pipe meeting sulfate-resistant concrete plan requirements (when applicable).

Clearly mark 1 end of each section during the process of manufacture or immediately thereafter for pipe with elliptical reinforcement. Mark the pipe on the inside and outside of opposite walls to show the location of the top or bottom of the pipe as it should be installed unless the external shape of the pipe is such that the correct position of the top and bottom is obvious. Mark the pipe section by indenting or painting with waterproof paint.

2.4. **Inspection**. Provide access for inspection of the finished pipe at the project site before and during installation.

2.5. **Causes for Rejection**. Individual section of pipe may be rejected for any of the conditions stated in the Annex of DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification."

2.6. **Repairs**. Make repairs if necessary as stated in the Annex of DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification."

2.7. **Jointing Materials**. Use any of the following materials for the making of joints unless otherwise shown on the plans. Furnish a manufacturer's certificate of compliance for all jointing materials except mortar.

2.7.1. **Mortar**. Provide mortar for joints that meets the requirements of Section 464.3.3., "Jointing."

2.7.2. **Cold-Applied, Plastic Asphalt Sewer Joint Compound**. Provide a material that consists of natural or processed asphalt base, suitable volatile solvents, and inert filler. Ensure the consistency is such that the ends of the pipe can be coated with a layer of the compound up to 1/2 in. thick by means of a trowel. Provide

a joint compound that cures to a firm, stiff plastic condition after application. Provide a material of a uniform mixture. Stir any small separation found in the container into a uniform mix before using.

Provide a material that meets the requirements of Table 4 when tested in accordance with Tex-526-C.

Table 4
Cold-Applied, Plastic Asphalt Sewer Joint Compound Material Requirements

Composition	Analysis
Asphalt base, 100%–% volatiles–% ash, % by weight	28–45
Volatiles, 212°F evaporation, 24 hr., % by weight	10–26
Mineral matter, determined as ash, % by weight	30–55
Consistency, cone penetration, 150 q, 5 sec., 77°F	150–275

2.7.3. **Rubber Gaskets**. Provide gaskets that conform to ASTM C1619 Class A or C. Meet the requirements of ASTM C443 for design of the pipe joints and permissible variations in dimensions.

2.7.4. **Pre-Formed Flexible Joint Sealants**. Pre-formed flexible joint sealants may be used for sealing joints of tongue-and-groove concrete pipe. Provide flexible joint sealants that meet the requirements of ASTM C990. Use flexible joint sealants that do not depend on oxidizing, evaporating, or chemical action for its adhesive or cohesive strength. Supply in extruded rope form of suitable cross-section. Provide a size of the pre-formed flexible joint sealant in accordance with the manufacturer's recommendations and large enough to properly seal the joint. Protect flexible joint sealants with a suitable wrapper able to maintain the integrity of the jointing material when the wrapper is removed.

3. CONSTRUCTION

3.1. **Excavation, Shaping, Bedding, and Backfill**. Excavate, shape, bed, and backfill in accordance with Item 400, "Excavation and Backfill for Structures," except where jacking, boring, or tunneling methods are permitted. Jack, bore, or tunnel the pipe in accordance with Item 476, "Jacking, Boring, or Tunneling Pipe or Box." Immediate backfilling is permitted if joints consist of materials other than mortar. Take special precautions in placing and compacting the backfill to avoid any movement of the pipe or damage to the joints. Do not use heavy earth-moving equipment to haul over the structure until a minimum of 4 ft. of permanent or temporary compacted fill has been placed over the structure unless otherwise shown on the plans or permitted in writing. Remove and replace pipe damaged by the Contractor at no expense to the Department.

3.2. **Laying Pipe**. Start the laying of pipe on the bedding at the outlet end with the spigot or tongue end pointing downstream, and proceed toward the inlet end with the abutting sections properly matched, true to the established lines and grades unless otherwise authorized. Fit, match, and lay the pipe to form a smooth, uniform conduit. Cut cross trenches in the foundation to allow the barrel of the pipe to rest firmly upon the bedding where bell-and-spigot pipe is used. Cut cross trenches no more than 2 in. larger than the bell ends of the pipe. Lower sections of pipe into the trench without damaging the pipe or disturbing the bedding and the sides of the trench. Carefully clean the ends of the pipe before the pipe is placed. Prevent the earth or bedding material from entering the pipe as it is laid. Lay the pipe in the trench, when elliptical pipe with circular reinforcing or circular pipe with elliptical reinforcing is used, so the markings for the top or bottom are not more than 5° from the vertical plane through the longitudinal axis of the pipe. Remove and re-lay, without extra compensation, pipe that is not in alignment or shows excessive settlement after laying.

Lay multiple lines of reinforced concrete pipe with the centerlines of the individual barrels parallel. Use the clear distances between outer surfaces of adjacent pipes shown in Table 5 unless otherwise shown on the plans. Use the equivalent diameter from Table 2 or Table 3 for arch pipe or horizontal elliptical pipe to determine the clear distance requirement in Table 5.

Table 5
Minimum Clear Distance between Pipes

Equivalent Diameter	Min Clear Distance
18 in.	9 in.
24 in.	11 in.
30 in.	1 ft. 1 in.
36 in.	1 ft. 3 in.
42 in.	1 ft. 5 in.
48 in.	1 ft. 7 in.
54 in.	1 ft. 11 in.
60 to 84 in.	2 ft.

3.3. **Jointing**. Make available an appropriate rolling device similar to an automobile mechanic's "creeper" for conveyance through small-size pipe structures.

3.3.1. **Joints Sealed with Hydraulic Cement Mortar**. Use Type S mortar meeting the requirements of ASTM C270. Clean and wet the pipe ends before making the joint. Plaster the lower half of the bell or groove and the upper half of the tongue or spigot with mortar. Pack mortar into the joint from both inside and outside the pipe after the pipes are tightly jointed. Finish the inside smooth and flush with adjacent joints of pipe. Form a bead of semicircular cross-section over tongue-and-groove joints outside the pipe, extending at least 1 in. on each side of the joint. Form the mortar for bell-and-spigot joints to a 45° fillet between the outer edge of the bell and the spigot. Cure mortar joints by keeping the joints wet for at least 48 hr. or until the backfill has been completed, whichever comes first. Place fill or backfill once the mortar jointing material has cured for at least 6 hr. Conduct jointing only when the atmospheric temperature is above 40°F. Protect mortared joints against freezing by backfilling or other approved methods for at least 24 hr.

Driveway culverts do not require mortar banding on the outside of the pipe.

Furnish pipes, with approval, that are large enough for a person to enter with the groove between 1/2 in. and 3/4 in. longer than the tongue. Such pipe may be laid and backfilled without mortar joints. Clean the space on the interior of the pipe between the end of the tongue and the groove of all foreign material, thoroughly wet and fill with mortar around the entire circumference of the pipe, and finish flush after the backfilling has been completed.

3.3.2. **Joints Using Cold-Applied, Plastic Asphalt Sewer Joint Compound**. Ensure both ends of the pipes are clean and dry. Trowel or otherwise place a 1/2–in. thick layer of the compound in the groove end of the pipe covering at least 2/3 of the joint face around the entire circumference. Shove home the tongue end of the next pipe with enough pressure to make a tight joint. Remove any excess mastic projecting into the pipe after the joint is made. Backfill after the joint has been inspected and approved.

3.3.3. **Joints Using Rubber Gaskets**. Make the joint assembly according to the recommendations of the gasket manufacturer. Make joints watertight when using rubber gaskets. Backfill after the joint has been inspected and approved.

3.3.4. **Joints Using Pre-Formed Flexible Joint Sealants**. Install pre-formed flexible joint sealants in accordance with the manufacturer's recommendations. Place the joint sealer so no dirt or other deleterious materials come in contact with the joint sealing material. Pull or push home the pipe with enough force to properly seal the joint. Remove any joint material pushed out into the interior of the pipe that would tend to obstruct the flow. Store pre-formed flexible joint sealants in an area warmed naturally or artificially to above 70°F in an approved manner when the atmospheric temperature is below 60°F. Apply flexible joint sealants to pipe joints immediately before placing pipe in trench, and connect pipe to previously laid pipe. Backfill after the joint has been inspected and approved.

3.4. **Connections and Stub Ends**. Make connections of concrete pipe to existing pipes, pipe storm drains, or storm drain appurtenances as shown on the plans.

Mortar or concrete the bottom of existing structures if necessary to eliminate any drainage pockets created by the connections. Repair any damage to the existing structure resulting from making the connections.

Make connections between concrete pipe and corrugated metal pipe with a suitable concrete collar and a minimum thickness of 4 in. unless otherwise shown on the plans.

Finish stub ends for connections to future work not shown on the plans by installing watertight plugs into the free end of the pipe.

Fill lift holes with concrete, mortar, or precast concrete plugs after the pipe is in place.

4. MEASUREMENT

This Item will be measured by the foot. Measurement will be made between the ends of the pipe barrel along the flow line, not including safety end treatments. Safety end treatments will be measured in accordance with Item 467, "Safety End Treatment." Pipe that will be jacked, bored, or tunneled will be measured in accordance with Item 476, "Jacking, Boring, or Tunneling Pipe or Box." Measurement of spurs, branches, or new connecting pipe will be made from the intersection of the flow line with the outside surface of the pipe into which it connects. Where inlets, headwalls, catch basins, manholes, junction chambers, or other structures are included in lines of pipe, the length of pipe tying into the structure wall will be included for measurement, but no other portion of the structure length or width will be included.

For multiple pipes, the measured length will be the sum of the lengths of the barrels.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Reinforced Concrete Pipe," "Reinforced Concrete Pipe (Arch)," or "Reinforced Concrete Pipe (Elliptical)" of the size and D-load specified or of the size and class specified. This price is full compensation for constructing, furnishing, transporting, placing, and joining pipes; shaping the bed; cutting pipes on skew or slope; connecting to new or existing structures; breaking back, removing, and disposing of portions of the existing structure; replacing portions of the existing structure; cutting pipe ends on skew or slope; and equipment, labor, tools, and incidentals.

Protection methods for excavations greater than 5 ft. deep will be measured and paid for as required under Item 402, "Trench Excavation Protection," or Item 403, "Temporary Special Shoring." Excavation, shaping, bedding, and backfill will be paid for in accordance with Item 400, "Excavation and Backfill for Structures." When jacking, boring, or tunneling is used at the Contractor's option, payment will be made under this Item. When jacking, boring or tunneling is required, payment will be made under Item 476, "Jacking, Boring or Tunneling Pipe or Box."

Item 500
Mobilization

1. DESCRIPTION

Establish and remove offices, plants, and facilities. Move personnel, equipment, and supplies to and from the project or the vicinity of the project site to begin work or complete work on Contract Items. Bonds and insurance are required for performing mobilization.

For Contracts with emergency mobilization, provide a person and method of contact available 24 hrs. a day, 7 days a week unless otherwise shown on the plans. The time of notice will be the transmission time of the written notice or notice provided orally by the Department's representative.

2. MEASUREMENT

This Item will be measured by the lump sum or each as the work progresses. Mobilization is calculated on the base bid only and will not be paid for separately on any additive alternate items added to the Contract.

3. PAYMENT

For this Item, the adjusted Contract amount will be calculated as the total Contract amount less the lump sum for mobilization. Except for Contracts with callout or emergency work, mobilization will be paid in partial payments as follows:

- Payment will be made upon presentation of a paid invoice for the payment or performance bonds and required insurance,
- Payment will be made upon verification of documented expenditures for plant and facility setup. The combined amount for all these facilities will be no more than 10% of the mobilization lump sum or 1% of the total Contract amount, whichever is less,
- When 1% of the adjusted Contract amount for construction Items is earned, 50% of the mobilization lump sum bid or 5% of the total Contract amount, whichever is less, will be paid. Previous payments under this Item will be deducted from this amount,
- When 5% of the adjusted Contract amount for construction Items is earned, 75% of the mobilization lump sum bid or 10% of the total Contract amount, whichever is less, will be paid. Previous payments under the Item will be deducted from this amount,
- When 10% of the adjusted Contract amount for construction Items is earned, 90% of the mobilization lump sum bid or 10% of the total Contract amount, whichever is less, will be paid. Previous payments under this Item will be deducted from this amount,
- Upon final acceptance, 97% of the mobilization lump sum bid will be paid. Previous payments under this Item will be deducted from this amount, and
- Payment for the remainder of the lump sum bid for "Mobilization" will be made after all submittals are received, final quantities have been determined and when any separate vegetative establishment and maintenance, test, and performance periods provided for in the Contract have been successfully completed.

For projects with extended maintenance or performance periods, payment for the remainder of the lump sum bid for "Mobilization" will be made 6 months after final acceptance.

For Contracts with callout or emergency work, “Mobilization,” will be paid as follows:

- Payment will be made upon presentation of a paid invoice for the payment of performance bonds and required insurance,
- Mobilization for callout work will be paid for each callout work request, and
- Mobilization for emergency work will be paid for each emergency work request.

Item 502
Barricades, Signs, and Traffic Handling

1. DESCRIPTION

Provide, install, move, replace, maintain, clean, and remove all traffic control devices shown on the plans and as directed.

2. CONSTRUCTION

Comply with the requirements of Article 7.2., "Safety."

Implement the traffic control plan (TCP) shown on the plans.

Install traffic control devices straight and plumb. Make changes to the TCP only as approved. Minor adjustments to meet field conditions are allowed.

Submit Contractor-proposed TCP changes, signed and sealed by a licensed professional engineer, for approval. The Engineer may develop, sign, and seal Contractor-proposed changes. Changes must conform to guidelines established in the TMUTCD using approved products from the Department's Compliant Work Zone Traffic Control Device List.

Maintain traffic control devices by taking corrective action when notified. Corrective actions include, but are not limited to, cleaning, replacing, straightening, covering, and removing devices. Maintain the devices such that they are properly positioned and spaced, legible, and have retroreflective characteristics that meet requirements day or night and in all weather conditions.

The Engineer may authorize or direct in writing the removal or relocation of project limit advance warning signs. When project limit advance warning signs are removed before final acceptance, provide traffic control in accordance with the TMUTCD for minor operations as approved.

Remove all traffic control devices upon completion of the work as shown on the plans or as directed.

3. MEASUREMENT

Barricades, Signs, and Traffic Handling will be measured by the month. Law enforcement personnel with patrol vehicles will be measured by the hour for each person.

4. PAYMENT

4.1. **Barricades, Signs, and Traffic Handling**. Except for Contracts with callout work and work orders, the work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Barricades, Signs, and Traffic Handling." This price is full compensation for installation, maintenance, adjustments, replacements, removal, materials, equipment, labor, tools, and incidentals.

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Barricades, Signs, and Traffic Handling." This price is full compensation for installation, maintenance, adjustments, replacements, removal, materials, equipment, labor, tools, and incidentals.

When the plans establish pay items for particular work in the TCP, that work will be measured and paid under pertinent Items.

4.1.1. **Initiation of Payment**. Payment for this Item will begin on the first estimate after barricades, signs, and traffic handling devices have been installed in accordance with the TCP and construction has begun.

4.1.2. **Paid Months**. Monthly payment will be made each succeeding month for this Item provided the barricades, signs, and traffic handling devices have been installed and maintained in accordance with the TCP until the Contract amount has been paid.

If, within the time frame established by the Engineer, the Contractor fails to provide or properly maintain signs and barricades in compliance with the Contract requirements, as determined by the Engineer, the Contractor will be considered in noncompliance with this Item. No payment will be made for the months in question, and the total final payment quantity will be reduced by the number of months the Contractor was in noncompliance.

4.1.3. **Maximum Total Payment Before Acceptance**. The total payment for this Item will not exceed 10% of the total Contract amount before final acceptance in accordance with Article 5.12., "Final Acceptance." The remaining balance will be paid in accordance with Section 502.4.1.5., "Balance Due."

4.1.4. **Total Payment Quantity**. The quantity paid under this Item will not exceed the total quantity shown on the plans except as modified by change order and as adjusted by Section 502.4.1.2., "Paid Months." An overrun of the plans quantity for this Item will not be allowed for approving designs; testing; material shortages; closed construction seasons; curing periods; establishment, performance, test, and maintenance periods; failure to complete the work in the number of months allotted; nor delays caused directly or indirectly by requirements of the Contract.

4.1.5. **Balance Due**. The remaining unpaid months of barricades less non-compliance months will be paid on final acceptance of the project, if all work is complete and accepted in accordance with Article 5.12., "Final Acceptance."

4.1.6. **Contracts with Callout Work and Work Orders**. The work performed and the materials furnished with this Item and measured as provided under "Measurement," will be considered subsidiary to pertinent Items, except for federally funded Contracts.

4.2. **Law Enforcement Personnel**. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement," will be paid by Contractor force account for "Law Enforcement Personnel." This price is full compensation for furnishing all labor, materials, supplies, equipment, patrol vehicle, fees, and incidentals necessary to complete the work as directed.

Item 550
Chain Link Fence

1. DESCRIPTION

Furnish, install, remove, repair, or replace chain link fence and gates.

2. MATERIALS

Furnish certification from the chain link fence materials manufacturer stating that all fencing materials comply with the requirements of this Item before installation of the fence. Use only new materials.

2.1. **General**. Furnish materials in accordance with the following:

- Item 421, "Hydraulic Cement Concrete," Class B
- Item 445, "Galvanizing"

2.2. **Wire Fabric**. Provide wire fabric with:

- 9 gauge (0.148 in. diameter) steel wire with a minimum breaking strength of 1,290 lb. meeting ASTM A392 Class I or ASTM A491;
- mesh size of 2 in. ±1/8 in. between parallel wires with at least 7 meshes in a vertical dimension of 23 in. along the diagonals of the openings; and
- knuckled selvages at the top and bottom edge of the fabric, unless otherwise shown on the plans.

2.3. **Posts**. Provide posts of the size and weight shown on the plans. Do not provide rerolled or open-seam posts. Use material for all posts meeting ASTM F1043 Group 1A Regular Grade or Group 1C High Strength.

2.4. **Post Caps**. Provide malleable iron post caps designed to exclude all moisture. Furnish barbed wire support arms integral with the post caps if barbed wire is shown on the plans. Furnish post caps with an opening for the top rail if top rail is shown on the plans. Post caps must have a 2-in. skirt.

2.5. **Gates**. Provide gates fabricated from round sections of pipe of the size and weight shown on the plans. Use material for all gate pipes meeting ASTM F1043 Group 1A Regular Grade or Group 1C High Strength. For each gate, include:

- corner and tee fittings of malleable iron or pressed steel with means for attaching diagonal bracing members;
- hinges of malleable iron allowing a full 180° swing, easily operated by one person;
- ball-and-socket-type bottom hinges that do not twist or turn from the action of the gate and prevent the closed gate from being lifted off the hinges;
- a positive stop that prevents any portion of the gate from swinging over an adjacent traffic lane;
- malleable iron pulley systems for roll type gate (only when required);
- diagonal braces consisting of 3/8-in. diameter cable with turnbuckles, 2 to each gate frame, and, for vehicle gates, a vertical pipe brace of the size and weight shown on the plans at the center of each gate leaf;
- latches of malleable iron or steel for single gates with a single-fork latch and padlock eye that will keep the gate closed;
- 2 fork latches mounted on a center plunger rod with a padlock eye for double-leaf gates;
- holdbacks for each leaf of vehicular gates, with a semi-automatic holdback catch anchored at least 12 in. into a 12-in. diameter by 24-in. deep concrete footing; and

- a malleable iron center rest, designed to receive the plunger rod anchored as shown on the plans for all double-leaf gates.

2.6. **Top Rail**. Use material meeting ASTM F1043 Group 1A or 1C for all top rail pipes. Provide 1.660 in. OD top rail manufactured from Group 1A standard weight (Schedule 40) steel pipe weighing 2.27 lb. per foot or from Group 1C high-strength pipe weighing 1.84 lb. per foot when shown on the plans. Provide pipe in sections at least 18 ft. long joined with outside steel sleeve couplings at least 6 in. long with a minimum wall thickness of 0.70 in. Use couplings designed to allow for expansion of the top rail.

2.7. **Tension Wire**. Use 7 gauge (0.177-in.) carbon steel wire with a minimum breaking strength of 1,950 lb. for the bottom edge of all fence fabric, and for the top edge of fence fabric when a top rail is not specified.

2.8. **Truss Bracing**. Provide truss bracing as shown on the plans.

2.9. **Cables**. Provide 7-wire strand cables manufactured of galvanized annealed steel at least 3/8 in. in diameter.

2.10. **Barbed Wire**. Provide 3 strands of twisted 12.5 gauge barbed wire with 2-point, 14 gauge barbs spaced approximately 5 in. apart conforming to ASTM A121 or ASTM A585 when specified on the plans.

2.11. **Barbed Wire Support Arms**. Provide support arms at an angle of 45° from vertical, with clips for attaching 3 strands of barbed wire to each support arm and sufficient strength to support a 200-lb. weight applied at the outer strand when barbed wire is specified on the plans.

2.12. **Stretcher Bars**. Provide stretcher bars made of flat steel at least 3/16 × 3/4 in. and not more than 2 in. shorter than the fabric height. Provide one stretcher bar for each gate and end post and 2 stretcher bars for each corner and pull post.

2.13. **Grounds**. Provide copper-clad steel rods 8 ft. long with a minimum diameter of 5/8 in., or other UL-listed ground rods.

2.14. **Miscellaneous Fittings and Fasteners**. Furnish enough fittings and fasteners to erect all fencing materials in a proper manner. Furnish fittings for posts from pressed or rolled steel, forged steel, malleable iron or wrought iron of good commercial quality spaced as shown on the plans.

2.15. **Coatings**. Hot-dip galvanize all materials unless specified otherwise in this Item or on the plans. Fabric, tension wire, and barbed wire may be aluminum-coated or alloy-coated if approved. Additionally coat all material except bolts, nuts, washers, and pipe material with thermally fused polyvinyl chloride (PVC) in accordance with ASTM F668, Class 2b, meeting the specified color when shown on the plans.

2.15.1. **Fabric**.

2.15.1.1. **Galvanizing**. Hot-dip galvanize in accordance with ASTM A392, Class I.

2.15.1.2. **Aluminum Coating**. Aluminum-coat in accordance with ASTM A491.

2.15.1.3. **Alloy Coating**. Coat with zinc-5% aluminum-mischmetal alloy (Zn-5A1-MM) in accordance with ASTM F1345, Class I.

2.15.2. **Posts, Braces, and Gates**.

2.15.2.1. **Standard Weight (Schedule 40) Pipe**. Hot-dip galvanize inside and outside according to ASTM F1043 (1.8 oz./sq. ft. galvanized zinc weight).

2.15.2.2. **High Strength Pipe**. Hot-dip galvanize before or after forming pipe according to ASTM F1043 Group 1C and as follows:

- Outside—minimum 0.9 oz./sq. ft. galvanized zinc weight with a verifiable polymer overcoat.

- Inside—minimum 0.9 oz./sq. ft. galvanized zinc weight before forming, or minimum 0.3 mils zinc-based coating after forming containing a minimum 90% zinc dust, by weight.

2.15.2.3. **Optional Additional Coating**. Additionally coat all pipe material with 10 mils minimum thermally fused PVC according to ASTM F1043, meeting the specified color when shown on the plans.

2.15.3. **Fittings, Bolts, and Other Miscellaneous Hardware**. Galvanize all fittings, bolts, and miscellaneous hardware in conformance with Item 445, "Galvanizing."

2.15.4. **Tension Wire**. Zinc-coat tension wire with a minimum coating of 0.80 oz./sq. ft. or aluminum-coat with a minimum coating of 0.30 oz./sq. ft.

2.15.5. **Barbed Wire**. Zinc-coat barbed wire in accordance with ASTM A121 (0.80 oz./sq. ft.) or aluminum-coat in accordance with ASTM A585 (0.30 oz./sq. ft.).

2.15.6. **Pull Cable**. Zinc-coat pull cable with a minimum coating of 0.80 oz./sq. ft. of individual-wire surface when tested in conformance with ASTM A116.

3. CONSTRUCTION

Erect the chain link fence to the lines and grades established on the plans. Overall height of the fence when erected is the height above the grade shown.

Repair or replace damaged fence or gates. Remove and replace the post and foundation if posts cannot be repaired by straightening. Return all salvageable material to the location shown on the plans when a fence installation is to be removed in its entirety and not replaced. Backfill all postholes with suitable material. Return the salvaged fence fabric in secured rolls not more than 50 ft. long. Dispose of unsalvageable material.

3.1. **Clearing and Grading**. Clear all brush, rocks, and debris necessary for the installation of this fencing.

Stake the locations for corner posts and terminal posts unless otherwise shown on the plans. Follow the finished ground elevations for fencing panels between corner and terminal posts. Level off minor irregularities in the path of the fencing.

3.2. **Erection of Posts**. Install posts as shown on the plans. Plumb and permanently position posts with anchorages firmly set before fabric is placed. Brace corner and pull posts as shown on the plans.

3.2.1. **Post Spacing**. Space posts as shown in Table 1.

Table 1
Post Spacing and Placement

Post Type	Required Spacing or Placement
Line posts	no more than 10 ft. apart
Pull posts	no more than 500 ft. apart and at each change in direction exceeding 20° vertically
Corner posts	at each horizontal angle point

Install cables on all terminal posts and extend to adjacent posts. Install cables on each side of corner and pull posts with a 3/8-in. drop-forged eye-and-eye or eye-and-clevis turnbuckle unless otherwise shown on the plans.

3.2.2. **Postholes**. Drill holes for concrete footings for all posts to provide footings of the dimensions shown on the plans.

Penetrate solid rock by at least 12 in. (18 in. for end, corner, gate, and pull posts) or to plan depth where the rock is encountered before reaching plan depth. Drill holes in the solid rock with a diameter at least 1 in. greater than the outside diameter of the post.

Fill the hole in the solid rock with grout consisting of 1 part hydraulic cement and 3 parts clean, well-graded sand after the posts are set and plumbed. If desired, other grouting materials may be used only if approved. Thoroughly work the grout into the hole, leaving no voids. Construct concrete footings from the solid rock to the top of the ground.

3.2.3. **Gate Posts**. Align the tops of all gate frames with the fencing top tension wire or top rail. Provide vehicular gates that are greater in overall height than the adjacent fencing by the height necessary to extend to within 2 in. of the pavement between the curbs if curbs are shown on the plans.

3.2.4. **Concrete Footings**. Center posts in their footings. Place concrete and compact by tamping or other approved methods. Machine mix all batches of concrete over 1/2 cu. yd. Hand mixing concrete is allowed on batches under 1/2 cu. yd.

Use forms for footings where the ground cannot be satisfactorily excavated to neat lines. Crown the concrete or grout (for solid rock) to carry water from the post. Keep the forms in place for at least 24 hr. Backfill the footing with moistened material as soon as each form is removed, and thoroughly tamp. Cover concrete with at least 4 in. of loose moist material, free of clods and gravel, immediately after placing concrete. No other curing is required.

Spread all excess excavated and loose material used for curing neatly and uniformly. Remove excess concrete and other construction debris from the site.

3.3. **Erection of Fabric**. Place the fabric with the cables drawn taut with the turnbuckles after all posts have been permanently positioned and anchorages firmly set. Secure one end and apply enough tension to the other end to remove all slack before making attachments. Cut the fabric and independently attach each span at all corner posts and pull posts unless otherwise shown on the plans.

Follow the finished contour of the site with the bottom edge of fabric located approximately 2 in. above the grade. Grade uneven areas so the maximum distance between the bottom of fabric and ground is 6 in. or less.

Fasten fabric at 12 in. intervals to the top and bottom tension wires between posts. Fasten the fabric in the same manner when top rail is shown on the plans. Fasten the fabric on gate frames to the top and bottom of the frame at 12 in. intervals. Use steel wire fabric ties of 9 gauge steel or larger. Fasten fabric to terminal posts by steel stretcher bars and stretcher bar bands fitted with carriage bolts and nuts of the size and spacing shown on the plans. Use stretcher bars to fasten end posts, pull posts, corner posts, and gateposts with stretcher bar bands at intervals of no more than 15 in. Attach stretcher bars to terminal posts with 1 × 1/8 in. flat steel bands with 3/8-in. carriage bolts at intervals up to 15 in.

3.4. **Electrical Grounds**. Provide at least one electrical ground for each 1,000 ft. of fence, located near the center of the run. Provide additional grounds directly under the point where power lines pass over the fence.

Vertically drive or drill in the grounding rod until the top of the rod is approximately 6 in. below the top of the ground. Connect a No. 6 solid copper conductor to the rod and to the fence by a UL-listed method so that each element of the fence is grounded.

3.5. **Repair of Coatings**. Repair damaged zinc coating in accordance with Section 445.3.5., “Repairs.”

4. MEASUREMENT

Chain link fence will be measured by the foot of fence installed, repaired, replaced, or removed, measured at the bottom of the fabric along the centerline of the fence from center to center of posts, excluding gates.

Gates will be measured as each gate installed, repaired, replaced, or removed.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Chain Link Fence (Install)" or "Chain Link Fence (Repair)" of the height specified or "Chain Link Fence (Remove)" and "Gate (Install)" or "Gate (Repair)" of the type, height, and width of opening specified or "Gate (Remove)." Clearing and grading for fencing and gates will not be paid for directly but is subsidiary to this Item.

5.1. **Chain Link Fence (Install)**. This price is full compensation for furnishing and installing fencing, except gates; cleaning, grading, and backfilling; removing and disposing of surplus material; and equipment, labor, tools, and incidentals.

5.2. **Chain Link Fence (Repair)**. This price is full compensation for furnishing materials; repairing or replacing fencing, except gates; cleaning, grading, and backfilling; removing and disposing of surplus or damaged material; and equipment, labor, tools, and incidentals.

5.3. **Chain Link Fence (Remove)**. This price is full compensation for removing all fencing, except gates; cleaning, grading, and backfilling; removing and disposing of surplus material; and equipment, labor, tools, and incidentals.

5.4. **Gate (Install)**. This price is full compensation for installing gate and for providing materials, center anchorages, equipment, labor, tools, and incidentals.

5.5. **Gate (Repair)**. This price is full compensation for repairing or replacing gate and for furnishing materials; removing and disposing of damaged materials; and equipment, labor, tools, and incidentals.

5.6. **Gate (Remove)**. This price is full compensation for removing gate and for materials, equipment, labor, tools, and incidentals.

Item 636
Signs

1. DESCRIPTION

- **Installation**. Furnish, fabricate, and erect aluminum signs. Sign supports are provided for under other Items.
- **Replacement**. Replace existing signs on existing sign supports.
- **Refurbishing**. Refurbish existing aluminum signs on existing sign supports.

2. MATERIALS

2.1. **Sign Blanks**. Furnish sign blank substrates in accordance with DMS-7110, "Aluminum Sign Blanks," and in accordance with the types shown on the plans. Use single-piece sheet-aluminum substrates for Type A (small) signs and extruded aluminum substrates for Type G (ground-mounted) or Type O (overhead-mounted) signs.

2.2. **Sign Face Retroreflectorization**. Retroreflectorize the sign faces with flat surface reflective sheeting. Furnish sheeting that meets DMS-8300, "Sign Face Materials." Use retroreflective sheeting from the same manufacturer for the entire sign face background. Ensure that sign legend, symbols, borders, and background exhibit uniform color, appearance, and retroreflectivity when viewed both day and night.

2.3. **Sign Messages**. Fabricate sign messages to the sizes, types, and colors shown on the plans. Use sign message material from the same manufacturer for the entire message of a sign. Use screen ink and background reflective sheeting that are from the same manufacturer when fabricating signs.

- Ensure that the screened messages have clean, sharp edges and exhibit uniform color and retroreflectivity. Prevent runs, sags, and voids. Furnish screen inks in accordance with DMS-8300, "Sign Face Materials."
- Fabricate colored, transparent film legend, and retroreflectorized sheeting legend from materials that meet DMS-8300, "Sign Face Materials."
- Fabricate non-reflective black film legend from materials meeting DMS-8300, "Sign Face Materials."
- Furnish direct-applied route markers and other attachments within the parent sign face unless otherwise specified on the plans.

2.4. **Hardware**. Use galvanized steel, stainless steel, or dichromate-sealed aluminum for bolts, nuts, washers, lock washers, screws, and other sign assembly hardware. Use plastic or nylon washers to avoid tearing the reflective sheeting. Furnish steel or aluminum products in accordance with DMS-7120, "Sign Hardware."

When dissimilar metals are used, select or insulate metals to prevent corrosion.

3. CONSTRUCTION

3.1. **Fabrication**. Sign fabrication plants that produce permanent highway signs must be approved in accordance with DMS-7390, "Permanent Highway Sign Fabrication Plant Qualification." Furnish signs from prequalified fabrication plants listed in the Department's MPL.

3.1.1. **Sign Blanks**. Furnish sign blanks to the sizes and shapes shown on the plans and that are free of buckles, warps, burrs, dents, cockles, or other defects. Do not splice individual extruded aluminum panels.

Complete the fabrication of sign blanks, including the cutting and drilling or punching of holes, before cleaning and degreasing. After cleaning and degreasing, ensure the substrate does not come into contact with grease, oils, or other contaminants before the application of the reflective sheeting.

3.1.2. **Sheeting Application**. Apply sheeting to sign blanks in conformance with the sheeting manufacturer's recommended procedures.

When using rotational sensitive white sheeting, fabricate signs by applying the sheeting for cut-out legend, symbols, borders, and route marker attachments within the parent sign face with the identification marks or other orientation features in the optimum rotation as identified by the sheeting manufacturer.

Clean and prepare the outside surface of extruded aluminum flanges in the same manner as the sign panel face.

Minimize the number of splices in the sheeting. Overlap the lap-splices by at least 1/4 in. for encapsulated glass bead sheeting unless otherwise recommended by the reflective sheeting manufacturer. Use butt splices for prismatic reflective sheeting. Provide a 1 ft. minimum dimension for any piece of sheeting. Do not splice sheeting for signs fabricated with transparent screen inks or colored transparent films.

3.1.3. **Sign Assembly**. Assemble extruded aluminum signs in accordance with the details shown on the plans. Sign face surface variation must not exceed 1/8 in. per foot. Surface misalignment between panels in multi-panel signs must not exceed 1/16 in. at any point.

3.1.4. **Decals**. Code and apply sign identification decals in accordance with Item 643, "Sign Identification Decals."

3.2. **Storage and Handling**. Ship, handle, and store completed sign blanks and completed signs so that corners, edges, and faces are not damaged. Damage to the sign face that is not visible when viewed at a distance of 50 ft., night or day, will be acceptable. Replace unacceptable signs.

Store all finished signs off the ground and in a vertical position until erected. Store finished sheet aluminum substrate signs in a weatherproof building. Extruded aluminum substrate signs may be stored outside.

Stockpile salvageable materials at the location shown on the plans or as directed. Accept ownership of unsalvageable materials and dispose of them in accordance with federal, state, and local regulations.

3.3. **Cleaning**. Wash completed signs in the fabrication shop with a biodegradable cleaning solution acceptable to the manufacturers of the sheeting, colored transparent film, and screen ink to remove grease, oil, dirt, smears, streaks, finger marks, and other foreign material. Wash again before final inspection after erection.

3.4. **Installation**. Install signs as shown on the plans or as directed.

3.5. **Replacement**. Remove the existing signs from the existing supports and replace with new signs, including mounting hardware, as shown on the plans.

3.6. **Refurbishing**. Refurbish existing signs by providing and installing new messages and mounting hardware. Install new retroreflectorized legend and supplemental signs as shown on the plans.

3.7. **Documentation**. Provide the following documentation from the sign fabricator with each shipment of furnished signs:

- A notarized original of the Signing Material Statement (Form 2273) with the proper attachments for verification of compliance, and
- A notarized certification stating that the completed signs were fabricated in accordance with this Item and the plans.

4. MEASUREMENT

Signs installed or replaced will be measured by the square foot of the sign face. Signs refurbished will be measured by each sign.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Aluminum Signs," "Replacing Existing Aluminum Signs," or "Refurbishing Aluminum Signs," of the type specified.

5.1. **Installation**. This price is full compensation for furnishing and installing new signs and hardware; fabrication of sign panels; treatment of sign panels required before application of the background materials; application of the background materials and messages to the sign panels; furnishing and fabricating frames, wind beams and stiffeners; furnishing bolts, rivets, screws, fasteners, clamps, brackets, and sign support connections; assembling and erecting the signs; preparing and cleaning the signs; and materials, equipment, labor, tools, and incidentals.

5.2. **Replacement**. This price is full compensation for furnishing and installing new aluminum signs and hardware; removal of existing signs; fabrication of sign panels; treatment of sign panels required before application of the background materials; application of the background materials and messages to the sign panels; furnishing and fabricating frames, wind beams and stiffeners; furnishing bolts, rivets, screws, fasteners, clamps, brackets, and sign support connections; assembling and erecting the signs; preparing and cleaning the signs; salvaging and disposing of unsalvageable materials; and materials, equipment, labor, tools, and incidentals.

5.3. **Refurbishing**. This price is full compensation for modifying existing sign messages; removing and replacing existing route markers, reflectorized legend, or supplemental signs attached to the parent sign; preparing and cleaning the signs; furnishing sheeting and hardware; salvaging and disposing of unsalvageable materials; and materials, equipment, labor, tools, and incidentals.

Item 644
Small Roadside Sign Assemblies

1. DESCRIPTION

- **Installation**. Furnish, fabricate, and erect small roadside sign assemblies or bridge mounted clearance sign assemblies consisting of the signs, sign supports, foundations (when required), and associated mounting hardware.
- **Relocation**. Relocate existing small roadside sign assemblies or bridge mounted clearance sign assemblies, and furnish and fabricate material as required.
- **Removal**. Remove existing small roadside sign assemblies or bridge mounted clearance sign assemblies.

2. MATERIALS

Furnish all materials unless otherwise shown on the plans. Furnish only new materials. Furnish and fabricate materials that comply with the following Items and details shown on the plans:

- Item 421, “Hydraulic Cement Concrete”
- Item 440, “Reinforcement for Concrete”
- Item 441, “Steel Structures”
- Item 442, “Metal for Structures”
- Item 445, “Galvanizing”
- Item 636, “Signs”
- Item 643, “Sign Identification Decals”
- Item 656, “Foundations for Traffic Control Devices”

Use galvanized steel, stainless steel, dichromate sealed aluminum, or other materials shown on the plans for pipe, bolts, nuts, washers, lock washers, screws, and other sign assembly hardware. When dissimilar metals are used, select or insulate metals to prevent corrosion.

3. CONSTRUCTION

Construct foundations in accordance with Item 656, “Foundations for Traffic Control Devices.” Plumb sign supports. Do not spring or rake posts to secure proper alignment. Use established safety practices when working near underground or overhead utilities. Consult the appropriate utility company before beginning work.

3.1. **Fabrication**. Fabricate sign supports in accordance with Item 441, “Steel Structures.” Ensure all components fit properly.

Verify the length of each post for each sign before fabrication to meet field conditions and sign-mounting heights shown on the plans.

Hot-dip galvanize fabricated parts in accordance with Item 445, “Galvanizing.” Punch or drill any holes in steel parts or members before galvanizing. Repair galvanizing for any steel part or member damaged during assembly, transit, erection; or for any steel part or member welded, when permitted, after galvanizing. Perform all galvanizing repairs in accordance with Section 445.3.5., “Repairs.”

3.2. **Installation**. Locate and install sign supports as shown on the plans, unless directed to shift the sign supports within design guidelines to secure a more desirable location or avoid conflict with utilities and underground appurtenances. Stake sign support locations for verification by the Engineer.

Install stub posts of the type, spacing, orientation, and projection shown on the plans. Remove and replace posts damaged during installation at the Contractor's expense.

Connect the upper post sections to the stub post sections as shown on the plans. Torque connection bolts as shown on the plans.

Attach signs to supports in accordance with the plans and pertinent Items.

3.3. **Relocation**. Reuse the existing signs as required unless otherwise shown on the plans. Furnish and install new stub posts in new foundations for relocated sign assemblies. Erect the new supports on the new stub posts, and attach the existing signs to the supports in accordance with the plans and pertinent Items. Remove existing foundations to be abandoned in accordance with Section 644.3.4., "Removal."

3.4. **Removal**. Remove abandoned concrete foundations to 2 ft. below finish grade unless otherwise shown on the plans. Cut off and remove steel protruding from the remaining concrete. Backfill the remaining hole with material equal in composition and density to the surrounding area. Replace any surfacing with like material to equivalent condition.

3.5. **Handling and Storage**. Handle and store existing signs or portions of signs removed so they are not damaged. Prevent any damage to the various sign assembly components. Replace any portion of the sign damaged by the Contractor designated for reuse or salvage, including messages removed.

Stockpile all removed sign components that will be reused or become the property of the Department at designated locations. Accept ownership of unsalvageable materials, and dispose of them in accordance with federal, state, and local regulations.

3.6. **Cleaning**. Wash the entire sign after installation with a biodegradable cleaning solution acceptable to the sign face materials manufacturer to remove dirt, grease, oil smears, streaks, finger marks, and other foreign materials.

4. MEASUREMENT

This Item will be measured as each small roadside assembly or bridge mounted clearance sign assembly installed, removed, or relocated.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Install Small Roadside Sign Assemblies" of the type specified, "Install Bridge Mounted Clearance Sign Assemblies" of the type specified, "Relocate Small Roadside Sign Assemblies" of the type specified, "Relocate Bridge Mounted Clearance Sign Assemblies" of the type specified, "Remove Small Roadside Sign Assemblies," or "Remove Bridge Mounted Clearance Sign Assemblies."

5.1. **Installation**. This price is full compensation for furnishing, fabricating, galvanizing, and erecting the supports; constructing foundations including concrete (when required); furnishing complete signs including sign connections and all hardware; attaching the signs to the supports; preparing and cleaning the signs; and materials, equipment, labor, tools, and incidentals.

5.2. **Relocation**. This price is full compensation for removing existing sign assemblies and related materials; furnishing and installing new stub posts and new sign supports; constructing foundations including concrete

(when required); and new hardware; reinstallation of signs; preparing and cleaning the signs; salvaging; disposal of unsalvageable materials; removing existing foundations, backfilling, and surface placement; and materials, equipment, labor, tools, and incidentals.

5.3. **Removal**. This price is full compensation for removing existing sign assemblies and related materials; salvaging; disposal of unsalvageable materials; removing existing foundations, backfilling, and surface placement; and materials, equipment, labor, tools, and incidentals.