CITY OF SAN ANGELO, TEXAS

TECHNICAL SPECIFICATIONS
FOR

BELL STREET
PAVING, DRAINAGE, WATER AND WASTEWATER IMPROVEMENTS
PHASE I, II AND III

Brenda Gunter
Mayor

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Single Member District #2
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OCTOBER 2017

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SAN16188

SEAL SHEET

Section: RFCSP, Drainage

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

Section: RFCSP, Water and Wastewater

FREESE AND NICHOLS, INC.
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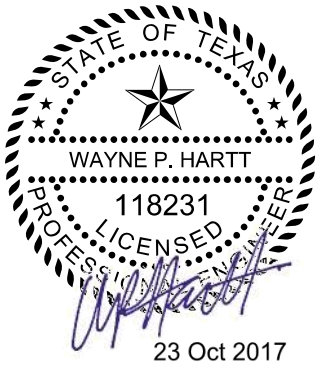
Section: Transportation



FREESE AND NICHOLS, INC.
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Section: Drainage

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City of San Angelo
Standard Specifications For Construction

PART I – CITY STANDARD WATER AND WASTEWATER TECHNICAL SPECIFICATIONS

4.0 - Utility Trench Repair Bid Sheet General Guidelines

4.0 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 of testing 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 lift every 300 LF
- Above pipe zone density: Perform test once each lift every 200 LF 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.

4.1.31 The City will perform all CCTV and associated cleaning of the existing SS main and new lines.

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

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 lump sum 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
e) Pressure Reducing 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.

4.14 - Service Lines

4.14.0 General

4.14.0.1 Scope

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

4.14.1 Materials

All 2” service lines will be Schedule 40 PVC. All 1” service lines will be Type K copper tubing.

4.14.2 Installation

It is intended that the line be laid to such a depth that there will be a minimum cover of thirty inches (30”). Where a line passes under the curb, the line shall be at least twenty-four (24") below the bottom of the curb. Where the existing meter location is more than five feet (5’) behind the curb line, at the direction of the OWNER, the CONTRACTOR shall relocate the meter to within five feet (5’) of the curb; including re-plumbing of the customer service line. Installation of a service line that replaces an existing service shall include disconnection and removal of the existing service line, installation of the new line, re-connection to the meter and re-connection of the private service line to the meter, resetting of the meter box and site grading and clean-up. The CONTRACTOR shall retain a Licensed Plumber for relocation of services on the customer side of the meter where applicable and shall obtain all permits and observe all plumbing code requirements of the City of San Angelo.

4.14.3 Relocation of Services

All existing alley services adjacent to the proposed water line street alignment shall be relocated to street side services, as noted on the plans. Where the existing meter location is more than five feet (5’) behind the curb line, at the direction of the OWNER, the CONTRACTOR shall relocate the meter to within five feet (5’) of the curb; including re-plumbing of the customer service line. For relocates, service lines on customer side of meter shall be a minimum of 1½” diameter but shall not be any smaller than the existing service line size. The CONTRACTOR shall retain a Licensed Plumber for relocation of services on the customer side of the meter where applicable and shall obtain all permits and observe all plumbing code requirements of the City of San Angelo.

4.14.4 Measurement and Payment

Service lines shall be measured per each by the various sizes, complete in place. Payment will be made at the unit price bid per each on the various sizes, which payment shall be full compensation for the service line installation complete in place, all in accordance with the plans and specifications.

4.16 - Cast in Place Concrete

4.16.0 General

4.16.0.1 Scope

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

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

4.16.1 Data and Drawings

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

4.16.2 Materials

a) **Cement** - ASTM C150, Type I, II, or III

b) **Fine Aggregate** - Clean natural sand, ASTM C33.Artificial or manufactured sand will not be acceptable.

c) **Coarse Aggregate** - Crushed rock, washed gravel, or other inert granular material conforming to ASTM C33, except that clay and shale particles shall not exceed one percent.

d) **Water** - Clean and free from deleterious substances.

e) **Admixtures**:

1. **Retarder** - ASTM C494, Type D; Grace "Daratard-HC", Master Builders "MB-HC", Protex "Protard", or Sika Chemical "Plastiment".

2. **Plasticizer** - ASTM C494, Type A; Grace "WRDA-HC", or Master Builders "MBHC-N".

3. **Super Plasticizer** - ASTM C494, Type F, American Admixtures "Melment 10A", Gifford-Hill "PSI-Super", Sida "Sikament", or W.R. Grace "WRDA-19".

4. **Air-Entraining** - ASTM C260; Grace "Darex AEA", Master Builders "MB-AE10", Protex "AES", or Sika Chemical "AER".

f) **Reinforcing Steel** - Bars, Except ASTM A615 (and Supplement S1) Weldable Grade 60, deformed. Bars, Weldable ASTM A706 or A615 (and Supplement S1) Grade 60, deformed, with maximum carbon equivalent of 0.55.

g) **Welded Wire Fabric** - ASTM A185 or A497.

h) **Bar Supports** - CRSI Class 1, plastic protected, or Class 2, stainless steel protected.

i) **Forms** - Prefabricated Simplex "Industrial Steel Frame Forms", Symons "Steel Ply", or Universal "Uni-form".

j) **Plywood** - Product Standard PS1, water-proof, resin-bonded, exterior type Douglas fir; face adjacent to concrete Grade B or better.

k) **Fiberboard** - Fed Spec LLL-B-810, Type II tempered, waterproof, creenback, concrete form hardboard.

l) **Lumber** - Straight, uniform width and thickness, and free from knots, offsets, holes, dents, and other surface defects.

m) **Chamfer Strips** - Clear white pine, surface against concrete planed.

n) **Form Coating** - Non-Crete "Form Coating", L&M "Debond", Protex "Pro-Cote, or Richmond "Rich Cote".

o) **Wedge Inserts** - Malleable iron, with galvanized askew-head bolts, nuts, and washers; Hohmann and Barnard "HW", Richmond "Peerless", or Weston "WC50".

p) **Polyethylene Film** - Product Standard PS17; 6 mil. Membrane Curing Fed Spec TT-C-800, Type I,

q) **Compound and Floor** - Class 1; min eighteen percent (18%) solids.

r) **Sealer** - Non-yellowing; unit moisture loss 0.039 gm/cm^2 max; ProSoCo "Dure and Seal", Protex "Acrychlor", or Sonneborm Kure-N-Seal".

4.16.3 Preliminary Review

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

4.16.4 Aggregates

Reports on aggregates shall include the following information:

a) Fine Aggregate.
   - Source and type
   - Gradation.

- Deleterious Substances.

b) Coarse Aggregate.
   - Source and type.
   - Gradation and abrasion loss.
   - Deleterious substances.
   - Results of sodium or magnesium sulfate soundness test.

4.16.5 Mix Design

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

a) Slump on which design is based.

b) Total gallons of water per cubic yard.

c) Brand, type, composition, and quantity of cement.

d) Specific gravity and gradation of each aggregate.

e) Ratio of fine to total aggregates.

f) Weight (surface dry) of each aggregate per cubic yard.

g) Brand, type, ASTM designation, active chemical ingredients, and quantity of each admixture.

h) Air content.

i) Compressive strength based on seven (7) day and twenty-eight (28) day compression tests.

j) Time of initial set.

4.16.6 Testing

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

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

shall be made, cured, and stored in conformity with ASTM C192 and tested in conformity with ASTM C39.

Slump shall be determined in accordance with ASTM C143 and total air content shall be determined in conformity with ASTM C231. Initial set tests shall be made at ambient temperatures of seventy degrees (70°F) and ninety degrees (90°F) to determine compliance with the initial set time specified hereinafter. The test at seventy degrees (70°F) shall be made using concrete containing the specified plasticizing and air-entraining admixtures. The test at ninety (90°F) shall be made using concrete containing the specified retarding and air-entraining admixtures. Initial set shall be determined in accordance with ASTM C403.

4.16.7 Limiting Requirements

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

4.16.7.1 Cement Content

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

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

4.16.7.2 Total Water Content

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

4.16.7.3 Slump

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

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

4.16.7.4 Ratio of Fine to Total Aggregates

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

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

4.16.7.5 Initial Set

The initial set as determined by ASTM C403 shall be attained 5 2 hours plus or minus one hour after the water and cement are added to the aggregates. The quantity of retarding or accelerating admixture shall be adjusted to compensate for variations in temperature and job conditions.

4.16.7.6 Total Air Content

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

4.16.7.7 Admixtures

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

4.16.7.8 Chloride Content

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

4.16.7.9 Storage of Materials

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

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

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

4.16.8 Forms

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

Forms for surfaces which will be exposed to view when construction is completed shall be prefabricated plywood panel forms, job-built plywood forms, or forms that are lined with plywood or fiberboard. Forms for exposed surfaces shall be laid out in a regular and uniform pattern with the long dimension of panels vertical and all joints aligned. The forms shall produce finished surfaces that are free from offsets, ridges, waves, and convex areas, within the tolerances specified herein.

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

4.16.8.1 Design

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

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

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

4.16.8.2 Form Ties

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

4.16.8.3 Edges and Corners

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

4.16.8.4 Form Removal

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

4.16.8.5 Reinforcements

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

4.16.8.6 Shop Drawings and Bar Lists

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

4.16.8.7 Placements

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

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

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

4.16.8.8 Splices

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

4.16.9 Embedments

Anchor bolts, castings, steel shapes, conduit, sleeves, masonry anchorage, and other materials that are to be embedded in the concrete shall be accurately positioned in the forms and securely anchored. Conduits shall be installed between the reinforcing steel in walls or slabs which have reinforcement in both faces. In slabs which have only a single layer of reinforcing steel, conduits shall be placed under the reinforcement. Unless installed in pipe sleeves, anchor bolts shall have sufficient threads to permit a nut to be installed on the concrete side of the form or template. A second nut shall be installed on the other side of the form or template and the two nuts shall be adjusted so that the bolt will be held rigidly in proper position.

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

4.16.10 Batching and Mixing

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

4.16.11 Consistency

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

4.16.12 Delivery Tickets

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

4.16.13 Placement

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

4.16.14 Bonding to Hardened Concrete

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

4.16.15 Conveying Concrete

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

4.16.16 Placing Concrete

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

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

4.16.17 Compaction

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

4.16.18 Cold Weather Concreting

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

Outdoor Temperature	Concrete Temperature
Below 30˚ F	70˚ F

Between 30˚ and 45˚ F	60˚ F
Above 45˚ F	45˚ F

When placed, heated concrete shall not be warmer than eighty degrees (80˚F). When freezing temperatures may be expected during the curing period, the concrete shall be maintained at a temperature of at least fifty degrees (50˚F) for five (5) days or seventy degrees (70˚F) for three (3) days after placement. Concrete and adjacent form surfaces shall be kept continuously moist. Sudden cooling of concrete shall not be permitted.

4.16.19 Hot Weather Concreting

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

4.16.20 Testing

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

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

4.16.20.1 Aggregate Gradation

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

4.16.20.2 Slump

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

4.16.20.3 Air Content

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

4.16.20.4 Compression Tests

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

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

4.16.20.5 Test Reports

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

4.16.21 Construction Joints

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

4.16.22 Watertight Joints

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

a) Walls in contact with liquid.

b) Other locations where specifically shown on the Plans.

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

4.16.23 Finishing Unformed Surfaces

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

4.16.24 Screeding

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

4.16.25 Floating

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

4.16.26 Broom Finish

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

4.16.27 Edging

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

4.16.28 Curing

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

4.16.29 Water Curing

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

4.16.30 Membrane Curing

Membrane curing compound shall be spray applied at coverage of not more than 300 square feet per gallon. Unformed surfaces shall be covered with curing compound within thirty (30) minutes after final finishing. If forms are removed before the end of the specified curing

period, curing compound shall be immediately applied to the formed surfaces before they dry out. Curing compound shall be suitably protected against abrasion during the curing period.

4.16.31 Film Curing

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

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

4.16.32 Repairing Defective Concrete

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

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

4.16.33 Finishing Formed Surfaces

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

4.16.34 Tie Holes

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

4.16.35 Tolerances

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

4.16.36 Surface Treatment

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

for surface treatment, all material, labor and resources are considered subsidiary to the item under construction.

4.16.37 Concrete for Pipe Blocking and Encasement

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

4.17 - Water Meter Change Out

4.17.0 General

Work under this item shall consist of changing out existing water meters in the OWNER's distribution system.

4.17.1 Work Orders

The OWNER will provide CONTRACTOR with a work order for each location where a meter is to be changed out. The work order will specify the address and identifying information on the existing meter. CONTRACTOR will be required to enter on the work order all required information for the meter removed and new meter installed at the address. Information includes but is not limited to: record/verify old meter serial number, old meter size, old meter manufacture number, old meter reading, new meter size, new meter manufacture number, new meter serial number, new meter reading, list of any parts required for change-out, indicate if meter box was changed, indicate if existing meter box was damaged, etc. Work orders shall be picked up and returned from 7:00 am to 8:00 am daily to the Water Distribution Center at 1948 St. Ann Street. A maximum of 4 work orders will be issued per work day (Monday through Friday, excluding OWNER's holidays) unless otherwise approved by OWNER. Additional work orders will not be issued until the previous work orders and their corresponding meters are completed and returned.

Work orders will be generated based on age of meter, meter locations (by zip codes and by address).

Meter change-out work will only be allowed from 8:00 am to 5:00 pm on Monday through Friday, excluding OWNER's holidays. CONTRACTOR will provide written notification to property indicating the work conducted and contact numbers in case of problems.

4.17.2 Meters and Related Appurtenances

Meter sizes that will be changed out are 5/8" x 3/4" and one inch (1"). OWNER will provide all meters, gaskets, meter spuds and meter risers to CONTRACTOR. Meters shall be picked up and returned daily to the Water Distribution Center. Broken and replaced parts will also be returned daily.

4.17.3 Meter Change-Out

CONTRACTOR shall make every attempt to notify occupants of building in person prior to turning off water service. If no answer is obtained, the CONTRACTOR shall verify that water is not being used. If water is being used, CONTRACTOR shall again attempt to notify occupants. If no answer is obtained, the CONTRACTOR shall note on the work order that water is being used. Once service is restored the CONTRACTOR shall note on the work order if water was again being used. Once the change-out is complete, the CONTRACTOR shall flush the service line by utilizing customer's facet, if available, and shall place a notice on the residence's door. Notices shall be approved by the OWNER prior to issuance by the CONTRACTOR. CONTRACTOR is responsible for providing all notices. CONTRACTOR shall be responsible for all work associated with change out of a meter. CONTRACTOR shall

clean out each meter box prior to commencing work. All accumulated material (soil, leaves, debris, etc.) shall be removed by means of water jetting and vacuum action to the bottom of the existing meter box or to the bottom of the existing meter whichever is greater. Work shall include but is not limited to; turning off water service line valve to meter, removing old meter, installing meter risers (required if top of existing meter is twelve inches (12") or more below existing ground), installing new meter, turning water back on, checking for and repairing any leak at the meter connections, digging up, removal and reinstalling the meter box if necessary to accomplish the change out. CONTRACTOR shall remain at the change out location until service has been restored (including any plumber repair work required). CONTRACTOR shall not proceed to next location until the customer's service has been restored.

4.17.4 Meter Boxes

Whenever CONTRACTOR discovers a broken meter box or lid; such broken unit shall be replaced by CONTRACTOR. Additionally, whenever the existing meter box is a concrete box; CONTRACTOR shall replace it with a new unit. OWNER shall supply all meter box replacement parts and complete boxes. Meter boxes and parts shall be picked up and returned to the Water Distribution Center. For the replacement of a concrete meter box; CONTRACTOR shall be compensated at the rate shown in the bid schedule. For all other replacement of meter boxes or parts; no additional compensation will be provided to CONTRACTOR and such work will be considered part of the meter change out. All additional parts required to complete the installation shall be duly noted on the corresponding work order. OWNER will not replace the part allotment provided to CONTRACTOR without proper work order documentation.

Meter boxes located such that demolition of existing asphalt or concrete is required to complete the meter change-out shall not be completed by CONTRACTOR. CONTRACTOR shall document circumstance on work order and return to OWNER. No additional compensation will be provided to CONTRACTOR.

4.17.5 Measurement and Payment

Water meters shall be measured per each by the various sizes, complete in place. Payment shall be at the unit price for each size of meter that is changed out. The unit price shall include full compensation for the water meter change-out complete in place, all in accordance with the plans and specifications, including all labor, tools, machinery, profit and overhead, insurance, etc.; required to accomplish the work.

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.

4.20 - Insertable Valves for Potable Water Mains

4.20.0 General

4.20.0.1 Scope

Under this item CONTRACTOR shall furnish all materials, labor, and equipment to properly install a full bore resilient seat gate valve onto existing pressurized potable water mains at the locations shown on the plans. The complete operation shall be completed while maintaining pressure on the existing main.

4.20.1 Experience

The following systems are approved:

- Advanced Valve Technologies, LLC [approved for four inches (4") through sixteen inches (16")]

- Hydra-Stop Inserta-Valve [approved for four inches (4") through sixteen inches (16")]

Requests to approve additional systems shall be submitted in writing to the City Engineer, Department of Water Utilities at least fourteen (14) days prior to the original bid opening date. The request shall include the company's experience, at least five (5) references of projects of a similar size and complexity as this project performed in the past three years and a description of the equipment and methods employed.

4.20.2 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. 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 excavate at another site.

4.20.3 Materials

Valves shall utilize the standard two inch (2") square nut for operation of valve. All materials utilized shall conform to the appropriate AWWA standards for material specifications. Clamps may be weld-on or bolted.

4.20.4 Installation

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.

Valve boxes shall be provided as described in Technical Specification 4.10, "Valves and Valve Installation".

4.20.5 Measurement and Payment

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

4.25 - Closed Bottom Fiberglass Manhole – Type A

4.25.0 General

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

4.25.1 Materials

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

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

c) **Interior Surfacing Material**: The inner surface exposed to the chemical environment shall be a resin-rich layer of 0.010 to 0.020 inch thick. The inner surface layer exposed to the corrosive environment shall be followed with a minimum of two passes of chopped roving of minimum length 0.5 inch (13 mm) to maximum length of two inches (2" / 50.8 mm) and shall be applied uniformly to an equivalent weight of three (3) oz. /ft. Each pass of chopped roving shall be well rolled prior to the application of additional reinforcement. The combined thickness of the inner surface and interior layer shall not be less than 0.10 inch (2.5 mm).

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

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

f) **Exterior Surface**: For a UV inhibitor the resin on the exterior surface of the manhole shall have gray pigment added to a minimum thickness 0.125 inches.

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

h) **Manhole Bottom**: Fiberglass manholes will be required to have resin fiber-reinforced bottom. Deeper manholes may require a minimum of two fiberglass channel stiffening supports. All fiberglass manholes manufactured with a fiberglass bottom will have a minimum three inch (3") wide anti-flotation ring. The manhole bottom shall be a minimum of ½ inch thick. Manholes shall be manufactured such that concrete is not required on the inside of the manhole. Manholes shall have a factory installed integral fiberglass bench and invert area.

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

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

4.25.2 Manufacture

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

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

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

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

4.25.3 Requirements

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

and wrinkles of 0.125 inch or greater in depth. Surface pits shall be permitted if they are less than 0.75 inch in diameter and less than 0.0625 inch deep. Voids that cannot be broken with finger pressure and are entirely below the resin surface shall be permitted if they are less than 0.5 inch in diameter and less than 0.0625 inch thick.

c) **Wall Thickness:** Fiberglass manholes forty-eight inches (48") in diameter and up to twenty feet (20') in depth will have a minimum wall thickness of 0.3125 inches. Fiberglass manholes forty-eight inches (48") in diameter and twenty feet (20') to thirty feet (30') in depth will have a minimum wall thickness of 0.5 inches.

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

e) **Manhole Length:** Manhole lengths shall be in six inch (6") increments ± two inches (2").

f) **Diameter Tolerance:** Tolerance of inside diameter shall be ± one percent (1%) of required manhole diameter.

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

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

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

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

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

4.25.4 Physical Properties

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

4.25.5 Test Methods

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

4.25.6 Quality Control

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

4.25.7 Certifications

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

4.25.8 Shipping and Handling

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

4.25.9 Installation

Bottom of excavation should be compacted to ninety-five percent (95%) Standard Proctor Density. Manholes shall have a poured reinforced concrete base at least one foot (1') deep and at least two feet (2') larger than fiberglass manhole outside diameter. The fiberglass manhole shall be lowered into the wet concrete and brought to plumb. Pour reinforced concrete over the anti-flotation flange.

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

4.25.10 Backfill

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

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

4.25.11 Marking and Identification

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

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

4.25.12 Measurement and Payment

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

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) This item pertains to Phase I of the Bell Street improvements.

b) 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.

c) 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, A4, A5, and A6, 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 48" SS Main during dry and/or low flow conditions to avoid providing bypass pumping at Station 1+00.
         a. By-Pass Pumping of the existing 12" SS will likely be Required to install Line A from 1+00 to 1+60.

   iii. For Connections to existing Laterals at 5+32, 9+04, 14+02 and 16+59 provide temporary by-pass pumping from existing lateral to the nearest active downstream manhole.

   iv. Proposed Sanitary Sewer Line B
      1. Existing 18" Sanitary Sewer:
         a. Provide temporary bypass pumping for the existing 18-inch sanitary sewer along the San Angelo draw from the proposed manhole near Station 2+00 to the nearest existing and active manhole on Preusser Street.
         b. Provide temporary bypass pumping for the existing 18-inch sanitary sewer near the alley between Koberlin Street and Spaulding Street from an existing active manhole

closest to the proposed line along Station 14+00 to 15+00 on Bell Street to a proposed manhole near Station 14+50 once line has been accepted and brought into service.

2. Existing 15” Sanitary Sewer: Provide temporary bypass pumping for the existing 15-inch sanitary sewer line located near the intersection of N Schroeder Avenue and Koberlin St. Test to ensure the proposed sanitary sewer from Station 2+00 to 15+00 is approved per specification prior to using for temporary bypass pumping. Provide temporary plug and bypass pumping from the existing 15-inch sanitary sewer line that connects with the existing 18-inch line along San Angelo draw to the proposed manhole nearest Station 2+00.

3. Existing 8” Sanitary Sewer: Provide temporary bypass pumping for the existing 8-inch sanitary sewer line located in the alley between Koberlin Street and Preusser Street. Test to ensure the proposed sanitary sewer from Station 2+00 to 15+00 is approved per specification prior to using for temporary bypass pumping. Provide temporary plug and bypass pumping from the existing 8-inch sanitary sewer line that connects with the existing 18-inch line along San Angelo draw to the proposed manhole nearest Station 2+00. For Connections to existing Laterals at 18+55, 23+65, 38+56 and 43+54 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) CONTRACTOR shall TV 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.

4.36 - Land Clearing and Grubbing

4.36.1 Description

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

4.36.2 Clearing, Grubbing and Chipping

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

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

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

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

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

4.36.3 Measurement and Payment

No additional payment shall be made for clearing, grubbing, chipping, removing, handling, spreading and disposal of vegetative material, as this work is considered subsidiary of the various pay items.

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.

4.48 - Fiberglass Manhole Liner

4.48.0 General

Fiberglass reinforced polyester manhole liner shall be manufactured from commercial grade polyester resin or vinyl ester resin, with fiberglass reinforcements. The resin system shall be suitable for atmospheres containing hydrogen sulfide and dilute sulfuric acid as well as other gases associated with the wastewater collection systems. The manhole liner shall be a one piece unit manufactured to meet or exceed all specifications of A.S.T.M. D-3753 latest edition as manufactured by L.F. Manufacturing, Inc., Giddings, Texas, 1-800-237-5791 or an approved equal.

4.48.1 Materials

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

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

c) **Interior Surfacing Material:** The inner surface exposed to the chemical environment shall be a resin-rich layer of 0.010 to 0.020 inch thick. The inner surface layer exposed to the corrosive environment shall be followed with a minimum of two (2) passes of chopped roving of minimum length of one-half inch (0.5” = 13 mm) to maximum length of two inches (2” = 50.8 mm) and shall be applied uniformly to an equivalent weight of three ounces per foot (3 oz. /ft). Each pass of chopped roving shall be well rolled prior to the application of additional reinforcement. The combined thickness of the inner surface and interior layer shall not be less than one-tenth inch (0.10” = 2.5 mm).

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

e) **Exterior Surface:** For a UV inhibitor the resin on the exterior surface of the manhole liner shall have gray pigment added for a minimum thickness 0.125 inches.

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

4.48.2 Manhole Liner Design

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

b) **Manway Reducer:** Manway reducers will be concentric with respect to the larger portion of the manhole liner diameters through sixty inches (60”). Larger manhole liners may have concentric or eccentric manway reducer openings.

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

4.48.3 Requirements

a) **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 0.5 inch in diameter, delamination or fiber show.

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

c) **Repairs:** Any manhole repair is subject to meet all requirements of this specification.

d) **Manhole Length:** Manhole lengths shall be in six inch (6”) increments ± two inches (2”).

e) **Diameter Tolerance:** Tolerance of inside diameter shall be ± one percent (1%) of required manhole diameter.

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

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

Stiffness Requirements	
Length (ft.)	**F/AY (psi)**
3.0 – 6.5	0.75
7.0 – 12.5	1.26
13.0 – 20.5	2.01
21.0 – 25.5	3.02
26.0 – 35.0	5.24

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

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

4.48.4 Physical Properties

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

4.48.5 Test Methods

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

4.48.6 Quality Control

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

4.48.7 Certifications

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

4.48.8 Shipping and Handling

Do not drop or impact the fiberglass manhole liner. Fiberglass manhole liner may be lifted by inserting a 4" x 4" x 30" timber into the top of manhole with cable attached or by a sling or "choker" connection around center of manhole, lift as required. Use of chains or cables in contact with the manhole surface is prohibited.

4.48.9 Backfill

a) **Backfill Material:** Unless shown otherwise on the Plans and approved by the engineer, concrete grout shall be used for backfill between the old manhole and the new fiberglass manhole liner. The backfill around the excavated reducer section shall be stabilized sand or crushed stone. The material chosen shall be free of large lumps or clods which will not readily break down under compaction. This material will be subject to approval by the engineer.

b) **Backfill Procedural:** The concrete grout backfill shall be poured in layers of not more than twelve inches (12”) in even lifts. The reducer section to be backfilled in twelve inch (12”) lifts evenly and compacted to ninety-five percent (95%) Standard Proctor Density.

4.48.10 Marking and Identification

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

1. Manufacturer’s Name or Trademark
2. Manufacturer’s Factory Location
3. Manufacturer’s Serial Number
4. Total Length

4.48.11 Measurement and Payment

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

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. 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.

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

4.53.0 General

4.53.0.1 Summary

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

b) Related Sections: Other Specification Sections, which directly relate to the work of this Section include, but are not limited to the following:
    1. Section 01 57 00 – Temporary Erosion and Sediment Control
    2. Section 31 00 00 – Earthwork
    3. Section 31 91 00 – Planting Preparation
    4. Section 32 92 00 – Turf and Grasses

4.53.0.1 Submittals

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

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

4.53.0.1 Delivery, Storage and Handling

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

4.53.1 Products

4.53.1.1 Acceptable Manufacturer

PROFILE Products LLC

750 Lake Cook Road – Suite 440

Buffalo Grove, IL 60089

800-366-1180 (Fax 847-215-0577)

www.profileproducts.com

4.53.1.2 Materials

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

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

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

2. Cover Factor is calculated as soil loss ratio of treated surface versus an untreated control surface.
3. % Effectiveness = One minus Cover Factor multiplied by 100%.
4. Large scale testing conducted at Utah Water Research Laboratory. For specific testing information please contact a Profile technical service representative at 866-325-6262.
5. Yield = (Mass per Unit Area)*(Thickness)*(Ground Cover Percentage).
6. Kinetic Energy Absorption Potential = (Wet Bond Strength)*(Thickness)
7. Functional Longevity is the estimated time period, based upon ASTM D5338 testing and field observations, that a material can be anticipated to provide erosion control and agronomic benefits as influenced by composition, as well as site-specific conditions, including; but not limited to – temperature, moisture, light conditions, soils, biological activity, vegetative establishment and other environmental factors.

4.53.1.3 Composition

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

1. Thermally Processed (within a pressure vessel) Wood Fiber – 80% + 3%
    - Heated to a temperature greater than 380 degrees Fahrenheit (193 degrees Celsius) for 5 minutes at a pressure greater than 50 psi (345 kPa)

   Crosslinked Biopolymers and Water Absorbents – 10% + 1%

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

   Micro-Pore Granules – 5% + 1%

4.53.1.4 Packaging

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

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

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

4.53.2 Execution

4.53.2.1 Substrate and Seedbed Preparation

a. Examine substrates and conditions where materials will be applied. Apply product to geotechnically stable slopes that have been designed and constructed to divert runoff away from the face of the slope. Do not proceed with installation until satisfactory conditions are established.
b. Depending upon project sequencing and intended application, prepare seedbed in compliance with other specifications under Section 1.01 B

4.53.2.2 Installation

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

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

1. Step One: Apply fertilizer with specified prescriptive agronomic formulations and 50% of seed with a small amount of HP-FGM for visual metering.
2. Step Two: Mix balance of seed and apply HP-FGM at a rate of 50 lb per 125 gallons (23 kg/475 liters) of water over freshly seeded surfaces. Confirm loading rates with equipment manufacturer. Do not leave seeded surfaces unprotected, especially if precipitation is imminent.

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

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

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

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

1. Fill 1/3 of mechanically agitated hydroseeder with water. Turn pump on for 15 seconds and purge and pre-wet lines. Turn pump off.
2. Turn agitator on and load low density materials first (i.e. seed).
3. Continue slowly filling tank with water while loading fiber matrix into tank.
4. Consult application and loading charts to determine number of bags to be added for desired area and application rate. Mix at a rate of 50 lb of HP-FGM per 125 gallons (23 kg/475 liters). Contact Equipment manufacturer to confirm optimum mixing rates.
5. All HP-FGM should be completely loaded before water level reaches 75% of the top of tank.
6. Top off with water and mix until all fiber is fully broken apart and hydrated (minimum of 10 minutes — increase mixing time when applying in cold conditions). This is very important to fully activate the bonding additives and to obtain proper viscosity.
7. Add fertilizer
8. Shut off recirculation valve to minimize potential for air entrainment within the slurry.
9. Slow down agitator and start applying with a 50-degree fan tip nozzle.
10. Spray in opposing directions for maximum soil coverage.

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

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

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

4.53.2.3 Cleaning and Protection

a) After application, thoroughly flush the tank, pumps and hoses to remove all material. Wash all material from the exterior of the machine and remove any slurry spills. Once dry, material will be more difficult to remove.
b) Clean spills promptly. Advise owner of methods for protection of treated areas. Do not allow treated areas to be trafficked or subjected to grazing.

4.55 – Automatic Meter Reader Installation

4.55.0 General

An Automatic Meter Reader (AMR) consists of a meter body, register, M.I.U. box, antenna, and associated wiring. CONTRACTOR shall be trained by the OWNER prior to working on or around any meter boxes. This training shall be held during the Pre-Construction Meeting.

OWNER will provide all materials necessary for the AMR installation. The CONTRACTOR is responsible for the accurate and complete installation of the materials provided by the OWNER. 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. If the CONTRACTOR damages or breaks the customer's service line, the CONTRACTOR is responsible for hiring a licensed plumber to make the repairs.

4.55.1 Installation

4.55.1.1 AMR Installation Process:

1. Customer Service (CS) prints AMR (blue) work orders for 5/8" and 1" accounts
2. CS provides Water Distribution (WD) with available cycle/route blue work orders and date they must be completed and returned to CS for input
3. WD assigns blue work orders to CONTRACTOR
4. WD trains CONTRACTOR personnel on installation and completion of blue work orders
    a. Confirm address and meter/serial number match
    b. Remove register and record old read on blue work order
    c. Install AMR register, MIU box and antenna
        i. If one already there, record information but do not exchange
    d. Record new meter number, MIU number and new read on blue work order
    e. Swipe AMR with magnet to activate (WD to supply magnet)
    f. Ensure all information is recorded on blue work order
    g. Securely replace meter lid
    h. Return completed blue work orders and old meter lids to WD
5. Minimum of 50 AMR installed daily
6. CONTRACTOR to carry small inventory of meter lids and boxes
7. All completed work orders must be returned to WD within 24 hours of completion
8. WD returns completed blue work orders to CS
9. CS to perform meter exchange

Please note:

- Any incorrect information (i.e. AMR installed at wrong address, etc.) will be corrected by the contractor at no charge to the city.

4.55.2 Payments

Payment for this item will be based on the lump sum price bid per each meter. Payment will include full compensation for installation, recording accurate and complete work orders, and returning of required materials to the OWNER in accordance with the specifications, Plans, and/or instructions of the OWNER.

PART II – CITY STANDARD TRANSPORTATION TECHNICAL SPECIFICATIONS

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 160

FURNISHING AND PLACING TOPSOIL

160.1 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 City.

160.2 MATERIALS.

(1) Topsoil. 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.

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

160.3 SOURCES.

The topsoil may be obtained from the right-of-way at sites of proposed excavation or embankment when shown on the Plans or designated by the City.

The approximate quantity of acceptable topsoil to be salvaged from the project will be shown on the Plans. The topsoil may also be obtained from approved sources, which are outside of the right-of-way and have been secured by the Contractor.

160.4 CONSTRUCTION METHODS.

Any trash, wood, brush, stumps or other objectionable materials encountered at the source shall be removed and disposed of as approved by the City prior to beginning of work required by this Item. The source and stockpile areas shall be kept drained, insofar as practicable, during the period of topsoil removal. The source and stockpile areas shall be left in a neat and presentable condition upon completion of the removal of all material required.

The placement of the topsoil shall be undertaken as soon as the grading operations have been completed or at such time as specified by the City. The topsoil shall be spread so as to form a cover of uniform thickness (loose) as shown on the Plans. After the topsoil has been placed and shaped, it shall be sprinkled and/or rolled if directed by the City. Rolling shall be performed with a light corrugated drum roller of the type approved by the City.

(1) Right-of-Way Sources. The existing topsoil shall be moved from within the limits of construction as shown on the Plans and stockpiled in a windrow along the right-of-way line, or at designated locations. It also may be spread over an area that is ready for topsoil application in accordance with the Plans or as directed by the City.

(2) Contractor-Obtained Sources. The Contractor shall notify the City sufficiently in advance of the opening of any material source to permit inspection of the site and to prepare for any necessary measurement. Only material, which meets the approval of the City, shall be utilized.

160.5 MEASUREMENT.

This Item will be measured by one of the following methods as shown on the Plans.

When Class 1 measurement is specified, topsoil will be measured by the 100-foot station as measured along the baseline of each roadbed.

When Class 2 measurement is specified, topsoil will be measured by the square yard complete in place.

When Class 3 measurement is specified, topsoil will be measured by the cubic yard in vehicles at the point of delivery.

When Class 4 measurement is specified, topsoil will be measured in the stockpile and the volume computed in cubic yards by the method of average end areas.

When Class 5 measurement is specified, topsoil will be measured in its original position at the source and the volume computed in cubic yards by the method of average end areas.

160.6 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 "Furnishing and placing Topsoil" of the class and 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.

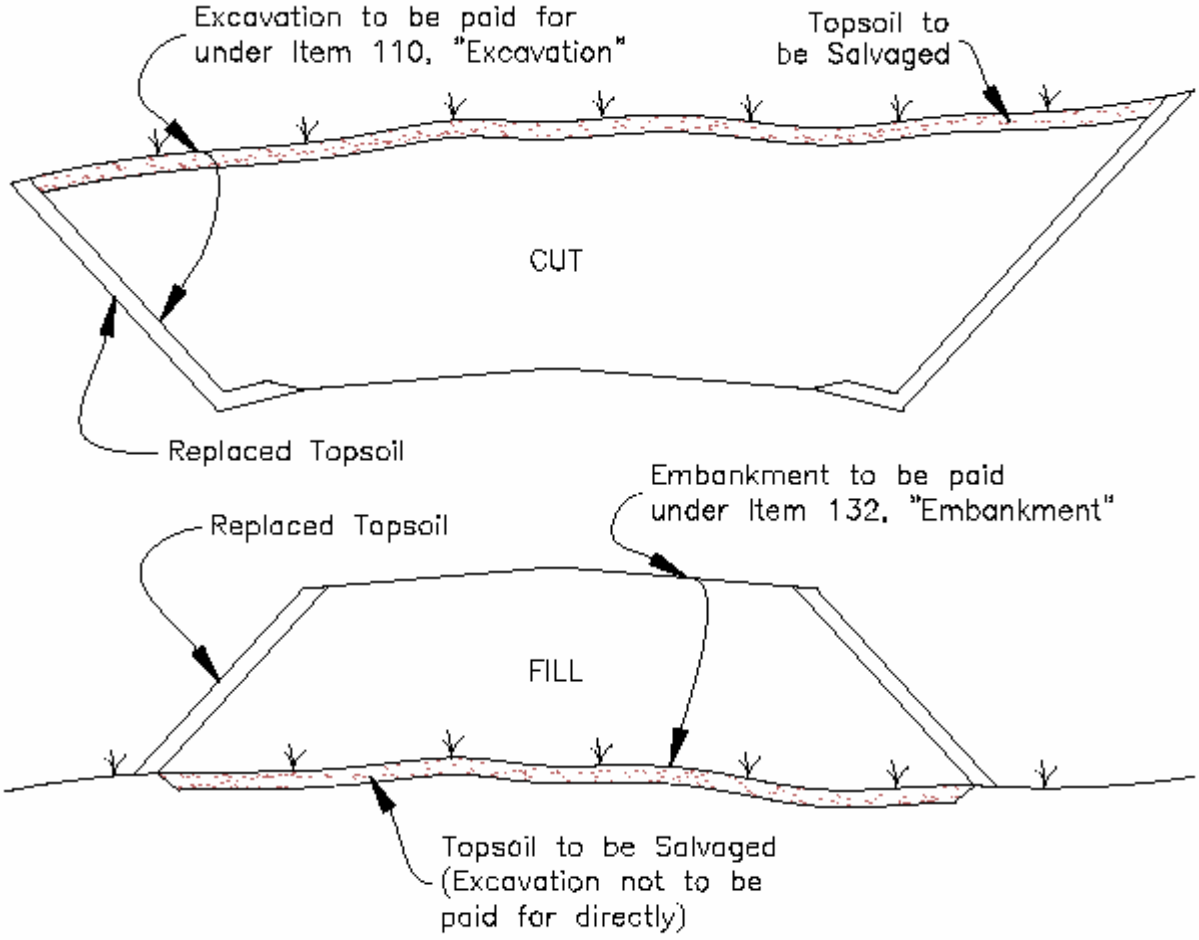
"Rolling" and "Sprinkling" will not be paid for directly, but will be considered subsidiary to this Item, unless otherwise shown on the Plans.

Payment will not be made for any material, which is used for purposes other than, that which is required by this Item.

Excavation required by this Item in cut sections will be measured and paid for in accordance with the provisions of the various excavation items involved, with the provision that excavation will be measured and paid for once only, regardless of the manipulations involved.

Excavation which will be paid for directly, in accordance with the various excavation Items involved, will include the original in-place volume of topsoil salvaged from cut sections, as well as the additional volume of excavation made necessary for placing the topsoil, in cut areas. Excavation, for topsoil, in areas upon which embankment will be placed will neither be measured nor paid for directly; its cost will be included in the unit price bid for this Item. The foregoing provisions are depicted in Figure 1.

Figure 1
Roadway Cross Sections Showing Payment for
Excavation and Embankment



CITY OF SAN ANGELO

ITEM 169

SOIL RETENTION BLANKET

169.1 DESCRIPTION.

This Item shall govern for providing and placing wood, straw or coconut fiber mat, synthetic mat, paper mat, jute mesh or other material as a soil retention blanket for erosion control on slopes or ditches or for short-term or long-term protection of seeded or sodded areas as shown on the Plans or as approved by the City.

169.2 MATERIALS.

(1) The soil retention blanket shall be one of the classes and types as shown on Plans or as listed below. Alternate materials may be used as approved by the City.

(a) Class 1. "Slope Protection"

i. Type A. Slopes 3:1 or flatter - Clay soils

ii. Type B. Slopes 3:1 or flatter - Sandy soils

iii. Type C. Slopes steeper than 3:1 - Clay soils

iv. Type D. Slopes steeper than 3:1 - Sandy soils

(b) Class 2. "Flexible Channel Liner"

i. Type E. Short-term duration (Up to 2 years)

Shear Stress (t_d) < 1.0 lb./sq. ft.

ii. Type F. Short-term duration (Up to 2 years)

Shear Stress (t_d) 1.0 to 2.0 lb./sq. ft.

iii. Type G. Long-term duration (Longer than 2 years)

Shear Stress (t_d) > 2.0 to < 5.0 lb./sq. ft.

iv. Type H. Long-term duration (Longer than 2 years)

Shear Stress (t_d) > or = to 5.0 lb./sq. ft.

(2) Fasteners. Fasteners shall conform to the requirements of the soil retention blanket manufacturer.

169.3 CONSTRUCTION METHODS:

(1) General. The soil retention blanket shall conform to the class and type shown on the Plans. The Contractor has the option of selecting an approved soil retention blanket conforming to the class and type shown on the Plans and according to the current approved material list.

(2) Installation. The soil retention blanket, whether installed as slope protection or as flexible channel liner in accordance with the approved materials list, shall be placed within 24 hours after seeding or sodding operations have been completed, or as approved by the City. Prior to placing the blanket, the area to be covered shall be relatively free of all rocks or clods over 1-1/2 inches in maximum dimension and all sticks or other foreign material which will prevent the close contact of the blanket with the soil. The area shall be smooth and free of ruts and other depressions. If as a result of rain, the prepared bed becomes crusted or eroded or if any eroded places, ruts or depressions exist for any reason, the Contractor shall be required to rework the soil until it is smooth and to re-seed or re-sod the area at the Contractor's expense.

Installation and anchorage of the soil retention blanket shall be in accordance with the manufacturer's recommendations.

(3) Literature. The Contractor shall submit one full set of manufacturer's literature and manufacturer's installation recommendations for the soil retention blanket selected in accordance with the approved material list.

169.4 MEASUREMENT.

This Item will be measured by the square yard of surface area covered.

169.5 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 “Soil Retention Blanket” of the class and type shown on the Plans. This price shall be full compensation for furnishing all materials, labor, tools, equipment and incidentals necessary to complete the work. Anchors, checks, terminals or junction slots, and wire staples or wood stakes will not be paid for directly but will be considered subsidiary to this Item.

CITY OF SAN ANGELO

ITEM 200

SUBGRADE PREPARATION

200.1 DESCRIPTION.

This Item shall govern the scarifying, blading, and rolling of the subgrade to obtain uniform texture and density throughout the required depth as shown on the Plans.

200.2 TESTING.

The subgrade under areas to be paved shall be compacted to a minimum depth of **8 inches** and to a density of **not less than 95 percent for cohesive soils** or **100 percent for noncohesive soils** of the maximum density as determined by Test Method Tex-114-E / ASTM D 698**.** Noncohesive soils, for the purpose of determining compaction control, are those with a plasticity index (PI) of less than 6. The material to be compacted shall be **within +/- 2 percent of optimum moisture content** before rolled to obtain the prescribed compaction (except for expansive soils).

Field density determination will be made in accordance with Test Method Tex-115-E / ASTM D 2922 for field density and ASTM D 3017 for moisture content using a nuclear gage. If nuclear gages are to be used for density determination, the machines shall be calibrated in accordance with ASTM D 2922 using blocks of materials with densities that extend through a range representative of the density of the proposed embankment material.

Compaction is to be tested for density and moisture content acceptance as per Detail S-EE-1.

AASHTO T99 or T-180 (Moisture-Density) is required for soils that have more than 30 percent retained on the 3/4-inch sieve. The moisture-density relationship test procedures ASTM D 698 and D1557 are not applicable for materials with greater than 30 percent retained on the 3/4-inch sieve. A replacement procedure (ASTM D 4718) for the coarse material (greater than 3/4-inch) is used with ASTM methods but only until up to 30 percent is retained. Maximum density testing (ASTM D 4253) may be used but it also limits the material retained on the 1-1/2-inch sieve to 30 percent. The AASHTO T-99 and T-180 are similar to ASTM D 698 and D 1557, except they do not limit the replacement of the coarse material.

Stones or rock fragments larger than 4 inches (100 mm) in their greatest dimension will not be permitted in the top 6 inches (150 mm) of the subgrade. The finished grading operations, conforming to the typical cross section, shall be completed and maintained at least 1,000 feet (300 m) ahead of the paving operations or as directed by the City.

200.3 CONSTRUCTION METHODS.

The roadbed or parking lot subgrade, as case may be, shall be excavated and shaped in conformity with the typical sections shown on the Plans and to the lines and grades established by the City. All unstable or otherwise objectionable material shall be removed or otherwise broken off to a depth of not less than six (6) inches below the surface of the subgrade. Holes or depressions resulting from the removal of such material shall be backfilled with suitable material compacted in layers not to exceed six (6) inches. All soft and unstable material and other portions of the subgrade, which will not compact readily or serve the intended purpose, shall be removed as directed. No direct payment will be made for such removal.

The subgrade shall be scarified to the depth shown on the Plans, then bladed and compacted in the manner outlined in the following paragraph, "Finishing and Compaction". The surface of the subgrade shall be finished to line and grade as established, and be in conformity with the typical sections shown on the Plans. Any deviation in excess of one-half (1/2) inch in cross section and in a length of sixteen feet measured longitudinally shall be corrected by loosening, adding or removing material, reshaping and compacting by sprinkling and rolling. Material excavated in the preparation of the subgrade shall be disposed in a manner acceptable to the City.

200.4 FINISHING AND COMPACTION.

The subgrade course, including an area one foot back of the proposed curb line, or as the case may be, shall be sprinkled as required and rolled as directed until a uniform compaction and the required density is obtained. Compaction of the subgrade may be done using any of the rolling equipment acceptable to the City. Rolling shall continue until the subgrade has been compacted to the required testing minimums per Section 200.2.

Tests will be made at the times and locations selected by the City. Notification will be a minimum of 24 hours.

Rolling shall progress gradually from the sides to the center of the lane under construction by lapping uniformly each preceding tract by at least 12 inches.

After rolling and watering, the subgrade shall be checked by the use of string line or instrument and all portions that do not conform to the lines and grades as shown on the Plans shall be scarified for at least six (6) inches, corrected and recompacted to correct elevations.

Until the base course or pavement is placed, the subgrade shall be maintained free from cuts and depressions, in a smooth and compacted condition true to lines and grade and to the density requirements contained herein. All of the Contractor's hauling and other equipment used in such a way as to cause rutting and raveling of the subgrade shall either be removed from the work or suitable run-ways or other equivalent means shall be provided to prevent rutting.

The Contractor shall be responsible for maintaining and protecting the roadbed or the parking lot subgrade, as the case may be, for the entire length of the project.

During construction, grading of the subgrade shall be conducted so that berms of earth or other material do not substantially impede the flow of storm waters. Ditches and drains along the subgrade shall be maintained so as to drain effectively.

200.5. MEASUREMENT.

The subgrade preparation will be measured by the number of square yards of subgrade prepared and accepted by the Owner.

200.6. PAYMENT.

The amount of subgrade area measured as outlined under "Measurement" will be paid for at a unit price bid for this Item which will be full compensation for removing excess material, shaping, fine grading and compacting the subgrade; for furnishing and hauling all materials, blading and finishing and all labor, tools and incidentals necessary to complete the work.

CITY OF SAN ANGELO

ITEM 210

ROLLING (FLAT WHEEL)

210.1 DESCRIPTION.

This Item shall govern for the compaction of embankment, flexible base, or surface treatments, by the operation of approved power rollers as herein specified and as directed by the City.

210.2 EQUIPMENT.

(1) Embankments and Flexible Bases. Power rollers shall be of the three-wheel, self-propelled type, weighing not less than ten (10) tons and shall provide compression on the rear wheels of not less than 325 pounds per linear inch of tire width. All wheels shall be flat; the rear wheels shall have a diameter of not less than 48 inches, and each shall have a tire width of not less than 20 inches.

210.3 CONSTRUCTION METHODS.

This work shall be done only when directed by the City. Sufficient rollers shall be provided to compact the material in a satisfactory manner. When operations are so isolated from one another that one roller unit cannot perform the required compaction satisfactorily, additional roller units shall be provided.

(1) Embankments and flexible Bases. The embankment layer or the base course shall be sprinkled if directed, and rolling with a power roller shall start longitudinally at the sides and proceed towards the center overlapping on successive trips by at least one-half (1/2) of the width of the rear wheel of the power roller. On superelevated curves, rolling shall begin at the low sides and progress toward the high sides. Alternate trips of the roller shall be slightly different in length. Rolling shall continue until discontinued by the City. The rollers, unless otherwise directed, shall be operated at a speed between two (2) and three (3) miles per hour.

(2) Surface Treatments. Rolling shall be done as called for in surface treatment items. The sequence of work shall be as specified for embankment layer or base course in accordance with Subarticle 210.3.(1) or as directed by the City. The operating speed shall be as directed by the City.

210.4 MEASUREMENT.

When shown on the Plans to be a pay item, this Item will be measured by the actual hours the power roller works as directed by the City.

210.5 PAYMENT.

The cost of furnishing and operating the equipment as prescribed by this Item will not be paid for directly but will be considered subsidiary to the various bid items of the contract, unless this Item is specified as a pay item in the contract.

When flat wheel rolling is specified as a pay item, the equipment furnished and operated in accordance with this item and measured and provided under "Measurement" will be paid for at the unit price bid for "Rolling (Flat Wheel)". This price shall be compensation for furnishing and operating all equipment; and for all labor, fuel, tools and incidentals necessary to satisfactorily perform the work.

CITY OF SAN ANGELO

ITEM 213

ROLLING (PNEUMATIC TIRE)

213.1 DESCRIPTION.

This Item shall govern for the compaction of embankment, flexible base, surface treatments, or pavements by the operation of approved pneumatic tire rollers as herein specified and as directed by the City.

213.2 EQUIPMENT.

(1) General. When used on seal coats, asphaltic surface treatments and bituminous mixture pavements, the roller shall be self-propelled and equipped with smooth tread tires whether "Rolling (Light Pneumatic Tire)" or "Rolling (Medium Pneumatic Tire)" is specified on the plans. The roller shall be so constructed as to be capable of being operated in both a forward and a reverse direction.

When used on bituminous mixture pavements, the roller shall have suitable provisions for moistening the surface of the tires while operating.

Where turning is impractical or detrimental to the work, and when specifically directed by the City, the roller shall be capable of being operated in a forward or backward motion.

In lieu of the rolling equipment specified, the Contractor may, upon written permission from the City, operate other compacting equipment that will produce equivalent relative compaction in the same period of time as would be expected of the specified equipment, as determined by the City, its use shall be discontinued and the Contractor will be required to furnish the specified equipment.

(2) The Light Pneumatic Tire Roller. It shall consist of not less than nine pneumatic tired wheels, running on axles in such manner that the rear group of tires will cover the entire gap between adjacent tires of the forward group, and mounted in a rigid frame and provided with a loading platform or body suitable for ballast loading. The front axle shall be attached to the frame in such manner that the roller may be turned within a minimum circle. The pneumatic tire roller under working conditions shall have an effective rolling width of approximately sixty inches and shall be so designed that by ballast loading, the total load may be varied uniformly from 9,000 to 18,000 pounds. The roller shall be equipped with tires that will afford ground contact pressures of 45 pounds per square inch (p.s.i.) or more. The operating load and tire air pressure shall be within the range of the manufacturer's charts or tabulations showing the contact areas and contact pressures for the full range of tire inflation pressures and for the full range of loadings for the particular tires furnished. The roller under working conditions shall provide a uniform compression under all wheels. Individual tire inflation pressures shall be within plus or minus five (5) p.s.i. of each other. The pneumatic tire roller shall be drawn by either a suitable crawler type tractor, a pneumatic tired tractor or a truck of adequate tractive effort, or may be of the self-propelled type,

and the roller, when drawn or propelled by either type of equipment, shall be considered a light pneumatic tire roller unit.

(3) The Medium Pneumatic Tire Roller (Type A). It shall consist of not less than seven (7) pneumatic tired wheels, running on axles in such manner that the rear group of tires will cover the entire gap between adjacent tires of the forward group, and mounted in a rigid frame and provided with a loading platform or body suitable for ballast loading. The front axle shall be attached to the frame in such manner that the roller may be turned within a minimum circle. The pneumatic tire roller under working conditions shall have an effective rolling width of approximately 84 inches and shall be so designed that by ballast loading the total load may be varied uniformly from 23,500 to 50,000 pounds. The roller shall be equipped with tires that will afford ground contact pressures to 80 p.s.i. or more. The operating load and tire air pressure shall be within the range of the manufacturer's chart as approved by the City. The roller under working conditions shall provide a uniform compression under all wheels. Individual tire inflation pressures shall be within plus or minus five (5) p.s.i. of each other.

The pneumatic tire roller shall be drawn by either a suitable crawler-type tractor, a pneumatic tired tractor or a truck of adequate tractive effort, or may be of the self-propelled type; and the roller, when drawn or propelled by either type of equipment, shall be considered a medium pneumatic tire roller unit. The power unit shall have adequate tractive effort to properly move the operating roller at variable uniform speeds up to approximately five (5) miles per hour.

(4) The Medium Pneumatic Tire Roller (Type B). It shall conform to the requirements for Medium Pneumatic Tire Roller, Type A as specified in Subarticle 213.2, except that the roller shall be equipped with tires that will afford ground contact pressures to 90 p.s.i. or more.

213.3 CONSTRUCTION METHODS.

This work shall be done only when directed by the City. The embankment layer or the base course shall be sprinkled if directed, and rolling with a pneumatic tire roller shall start longitudinally at the sides and proceed towards the center, overlapping on successive trips by at least one-half (1/2) of the width of the pneumatic tire roller. On superelevated curves, rolling shall begin at the low sides and progress toward the high sides. Alternate trips of the roller shall be slightly different in length. Rolling shall continue until discontinued by the City.

The light pneumatic tire roller shall be operated at speeds directed by the City which shall be between four (4) and twelve (12) miles per hour for asphalt surfacing work and between two (2) and six (6) miles per hour for all other work.

The medium pneumatic tire roller shall be operated at speeds as directed by the City.

Sufficient rollers shall be provided to compact the material in a satisfactory manner. When operations are so isolated from one another that one roller unit cannot perform the required compaction satisfactorily, additional roller units shall be provided.

213.4 MEASUREMENT.

When shown on the plans to be a pay item, this Item will be measured by the actual hours the pneumatic tire roller unit works as directed by the City.

213.5 PAYMENT.

The cost of furnishing and operating the equipment in accordance with this Item will not be paid for directly but will be considered subsidiary to the various bid items of the contract, unless this Item is specified as a pay item in the contract. When pneumatic rolling is specified as a pay item, the equipment furnished and operated in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Rolling (Light Pneumatic Tire)", "Rolling (Medium Pneumatic Tire) (Type A)" or "Rolling (Medium Pneumatic Tire) (Type B)". This price shall be full compensation for furnishing and operating all equipment, and for all labor, fuel, tools, and incidentals necessary to satisfactorily perform the work.

CITY OF SAN ANGELO

ITEM 216

ROLLING (PROOF)

216.1 DESCRIPTION.

This Item shall govern for furnishing and operating heavy pneumatic tired compaction equipment for locating unstable areas of earthwork or base.

216.2 EQUIPMENT.

The proofrolling equipment shall consist of not less than four (4) pneumatic tired wheels, running on axles carrying not more than two (2) wheels, and mounted in a rigid frame and provided with loading platform or body suitable for ballast loading. All wheels shall be arranged so that they will carry approximately equal loads when operating on uneven surfaces.

The proofroller under working conditions shall have a rolling width of from eight (8) feet to ten (10) feet, and shall be so designed that, by ballast loading, the gross load may be varied uniformly from 25 tons to 50 tons. The tires shall be capable of operating under various loads with variable air pressure up to 150 pounds per square inch. Tires shall be practically full of liquid. (Tires shall be considered as being practically full when liquid will flow from the valve stem of a fully inflated tire with the stem in the uppermost position). The operating load and tire pressure shall be within the range of the manufacturer's chart as directed by the Engineer. The Contractor shall furnish the Engineer charts or tabulations showing the contact areas and contact pressures for the full range of tire inflation pressures and for the full range of loading for the particular tires furnished.

The proofroller shall be towed by a suitable crawler-type tractor or rubber-tired tractor of adequate tractive capacity, or may be of the self-propelled type. A proofroller unit shall consist of either a self-propelled roller or combination of roller and towing tractor.

There shall be a sufficient quantity of ballast available to load the equipment to a maximum gross weight of 50 tons.

Rubber tired tractive equipment shall be used on base courses and asphalt pavements. Other type tractive equipment may be used on embankment subgrade. The heavy pneumatic tire roller unit shall be capable of turning 180 degrees in the crown width or operating in forward and reverse modes.

In lieu of the rolling equipment specified, the Contractor may, upon written permission from the Engineer, operate other compacting equipment that will produce equivalent results in the same period of time as the specified equipment. If the substituted compaction equipment fails to produce the desired results within the same period of time as would be expected of the specified equipment, as determined by the Engineer, its use shall be discontinued.

216.3 CONSTRUCTION METHODS.

This work shall be done only when directed by the Engineer. The subgrade and/or base layer shall be proofrolled to locate unstable areas when directed by the Engineer.

Within the ranges set forth in Article 216.2, the load and tire inflation pressures shall be adjusted as directed by the Engineer. It is proposed to use a contact pressure corresponding as nearly as practical to the maximum supporting value of the earthwork or base. A minimum of two (2) coverages of the proofroller shall be offset by not greater than one (1) tire width. Rollers shall be operated at speeds directed by the Engineer, which shall be between two (2) and six (6) miles per hour.

Where the operation of the proofroller unit shows an area to be unstable or non-uniform, it shall be corrected in accordance with the applicable Item of Work.

216.4 MEASUREMENT.

This Item will be measured by the actual hours the heavy pneumatic tire proofroller unit works as directed by the Engineer.

216.5 PAYMENT.

The equipment furnished and operated in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Rolling (Proof)". This price shall be full compensation for furnishing and operating all equipment; for all labor, tools, fuel and incidentals necessary to satisfactorily perform the work.

Unless otherwise provided on the Plans, payment for reworking unstable or uniform areas, removing and replacing materials, addition of stabilizing materials, and all compaction and incidentals necessary to correct all irregularities will not be made directly but will be considered as subsidiary to the various bid items.

CITY OF SAN ANGELO

ITEM 247

FLEXIBLE BASE

247.1. DESCRIPTION.

This Item shall govern for the delivery, stockpiling and/or the construction of foundation or base courses as herein specified and in conformity with the typical sections and to the lines and grades shown on the Plans or established by the City.

247.2. MATERIALS.

The flexible base material shall be crushed or uncrushed as necessary to meet the requirements herein, and shall consist of durable coarse aggregate particles and binding materials.

(1) Physical Requirements.

(a) General. All types shall meet the physical requirements for the specified grade(s) as set forth in Table 1. Additives, such as, but not limited to, lime, cement or fly ash, shall not be used to alter the soil constants or strengths shown in Table 1, unless otherwise shown on the Plans approved by the City.

The flexible base shall be:

(b) Type A. Type A material shall be crushed stone produced from oversize quarried aggregate, sized by crushing and produced from a naturally occurring single source. Crushed gravel or uncrushed gravel shall not be acceptable for Type A material. No blending of sources and/or additive materials will be allowed in Type A material, unless noted on the Plans or as approved by the City.

(2) Testing: Testing of flexible base materials shall be in accordance with the following TxDOT standard laboratory test procedures:

Moisture Content	Tex-103-E / ASTM D 2216
Liquid Limit	Tex-104-E / ASTM D 4318
Plasticity Index	Tex-106-E / ASTM D 4318
Bar Linear Shrinkage	Tex-107-E, (Part II) / NA
Sieve Analysis	Tex-110-E / ASTM D 422
Moisture-Density Determination	Tex-113-E / ASTM D 1557
Roadway Density	Tex-115-E / ASTM D 2922 and ASTM D 3017
Wet Ball Mill	Tex-116-E / NA
Triaxial Tests	Tex-117-E, (Part I or II as selected by the City) / NA
Particle Count	Tex-460-A, Part I / ASTM D 5821

Samples for testing the base material for triaxial class, soil constants, gradation, and wet ball mill will be taken prior to the compaction operations.

TABLE 1
MATERIAL REQUIREMENTS

Property	Test Method	Grade 2
Master gradation sieve Size (% retained)	Tex-110-E ./ ASTM D 422	
2-1/2 in.		0
1-3/4 in		0 - 10
7/8 in		---
3/8 in		---
No. 4		45 - 75
No. 40		60 - 85
Liquid Limit, % max. [1]	Tex-104-E / ASTM D 4318	40
Plasticity Index, max [1]	Tex-106-E / ASTM D 4318	12
Plasticity Index, max [1]		As shown on plans
Wet ball mill, % max.[2]	Tex-116-E / NA	45
Wet ball mill, % max. increase passing the No. 40 sieve		20
Classification [3]	Tex-117-E / NA	1.1 – 2.3
Minimum compressive strength [3], psi		
lateral pressure 0 psi		35
lateral pressure 15 psi		175

1. Determine plastic index in accordance with Tex-107-E / NA (linear shrinkage) when liquid limit is unattainable as defined in Tex-104-E / ASTM D 4318.
2. When a soundness value is required by the plans, test material in accordance with Tex-411-A / ASTM C 88.
3. Meet both the classification and the minimum compressive strength, unless otherwise shown on the plans.

(3) Tolerances. Unless otherwise shown on the Plans, the limits establishing reasonably close conformity with the specified gradation and plasticity index are defined by the following:

(a) Gradation. The City may accept the material, providing not more than one out of the most recent five (5) consecutive gradation tests performed are outside the specified gradation and plasticity index are defined by the following:

(b) Plasticity Index. The City may accept the material providing not more than one (1) out of the most recent five (5) consecutive plasticity index samples tested are outside the specified limit by no more than two (2) percentage points.

(4) Material Sources. The flexible base material shall be furnished by the Contractor. When a non-commercial source is utilized, it shall be opened in such manner as to immediately expose the vertical faces of all the various strata of acceptable material. Unless otherwise approved by the City, the material shall be secured and processed by successive vertical cuts extending through all of the exposed strata.

Unless otherwise shown on the Plans, the flexible base material shall be temporarily stockpiled prior to delivery to the roadway. Unless otherwise shown on the Plans, the stockpile shall not be less than ten (10) feet in height and shall be made up of layers not greater than two (2) feet in thickness. After a sufficient stockpile has been constructed, the Contractor may proceed with loading from the stockpile for delivery. In loading from the stockpile for delivery, the material shall be loaded by making successive vertical cuts through the entire depth of the stockpile.

When temporary stockpiles are to be tested for acceptance prior to delivery to its intended use, any stockpile that has been sampled and accepted shall not have material added or removed unless otherwise approved by the City. The Contractor will be charged for additional sampling and testing required as a result of material being removed from a previously approved stockpile without the approval of the City. Such charges will be deducted from the Contractor's estimates.

247.3. CONSTRUCTION METHODS.

(1) Complete in Place:

(a) Preparation of Subgrade or Existing Roadbed. Prior to delivery of the base material, the subgrade or existing roadbed shall be shaped to conform to the typical sections, shown on the Plans or established by the City. This work shall be done in accordance with the provision of the applicable bid items.

When shown on the Plans and directed by the City, the Contractor shall proof roll the roadbed in accordance with Item 216, “Rolling (Proof)”. Soft spots shall be corrected as directed by the City.

(b) First Course. It shall be the responsibility of the Contractor to deliver the required amount of base material to each 100-foot station. Base material shall be spread uniformly and shaped the same day as delivered. In the event inclement weather or other unforeseen circumstances render this impractical, the material shall be shaped as soon as practical.

Prior to compacting the flexible base, the flexible base material shall be bladed and shaped to conform to the typical sections as shown on the Plans. All areas of segregated coarse or fine material shall be corrected or removed and replaced with well-graded material, as directed by the City and at the Contractor's expense.

The Contractor shall sprinkle for dust control as directed by the City.

(c) Succeeding or Finish Courses. Construction methods shall be the same as required for the first course. Throughout this entire operation, the shape of each course shall be maintained by blading. Upon completion, the surface shall be smooth and in conformity with the typical section as shown on the Plans and the established lines and grades. Prior to placing the surfacing on the completed base, the base shall be cured to the extent directed by the City.

(d) Compaction Method. The flexible base shall be compacted by "Density Control" as shown on the Plans. Water used for compaction shall conform to the same water source requirements of Item 160.2(2).

The flexible base shall be sprinkled as required and compacted to the extent necessary to provide not less than 95 percent density as determined by TxDOT Test Method Tex-113-E / ASTM D 1557, unless otherwise shown on the Plans. After each section of flexible base is completed, tests as necessary will be made by the City in accordance with TxDOT Test Method Tex-115-E / ASTM D 2922 and ASTM D 3017. When the material fails to meet the density requirements, or it loses the required stability, density or finish before the next course is placed or the project is completed, it shall be reworked and retested in accordance with Section 247.3.(1)(e).

(e) Reworking a Section. Should the base course, due to any reason or cause, lose the required stability, density or finish before the surfacing is complete, it shall be reworked, recompacted and refinished at the sole expense of the Contractor.

(f) Tolerances. Tolerances shall conform to the following:

(i) Density Tolerances. The City may accept the work providing not more than one out of the most recent five consecutive density tests performed is below the specified density, and providing that the failing test is no more than three pounds per cubic foot below the specified density.

(ii) Grade Tolerances. In areas on which surfacing is to be placed, any deviation in excess of 1/4 inch in cross section or 1/4 inch in a length of 16 feet measured longitudinally shall be corrected by loosening, adding or removing material, reshaping and recompacting by sprinkling and rolling.

(g) Thickness Measurement. When the measurement is by the square yard, the flexible base will be measured for depth in units of 4,000 square yards, or fraction thereof. The measurements will be at location(s) determined by the City and performed in accordance with Test Method Tex-140-E. In any unit where flexible base is deficient by more than 1/2 inch in thickness, the deficiency shall be corrected by scarifying, adding material as required, reshaping, recompacting and refinishing at the Contractor's expense.

(2) Roadway Delivery. It shall be the responsibility of the Contractor to deliver the required amount of base material to each 100-foot station. All processing or manipulations will be in accordance with the applicable bid items.

(3) Stockpile Delivery. It shall be the responsibility of the Contractor to prepare the stockpile site, to provide and deliver the required amount of base material to the designated stockpile site and to construct the stockpile. Unless otherwise shown on the Plans, the stockpile shall not be

less than ten (10) feet in height and shall be made up of layers not to exceed two (2) feet in thickness.

247.4. MEASUREMENT.

This Item will be measured by either Measurement Class 1, 2, 3, 4, or 5 as shown on the Plans:

(1) Measurement Class 1. Measurement will be by the cubic yard in vehicles of uniform capacity.

(2) Measurement Class 2. Measurement will be by the ton of 2,000 pounds dry weight in vehicles as delivered. A set of standard platform truck scales conforming to the requirements of TxDOT Item 520, "Weighing and Measuring Equipment", shall be furnished by the Contractor and placed at a location approved by the City. When the material is weighed during mixing or batching, re-weighing will not be necessary. The dry weight will be determined by deducting the weight of the moisture in the material at the time of weighing from the gross weight of the material. The moisture in the material will be determined in accordance with Test Method Tex-103-E / ASTM D 2216 at least once each day and more often if conditions warrant.

(3) Measurement Class 3. Measurement will be by the cubic yard in the final stockpile position. The volume of flexible base will be computed in place between the natural ground and the top of the stockpile by the method of average end areas.

(4) Measurement Class 4. Measurement will be by the cubic yard in the completed and accepted final position. The volume of base course will be computed in place between the original subgrade or subbase surfaces, and the lines, grades and slopes of the accepted base course as shown on the Plans by the method of average end areas.

Measurement Class 4 is plan 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 Conditions of Contract Documents. If no adjustment is required, additional measurements or calculations will not be required. No payment will be made for thickness or width exceeding that shown on the typical section or provided on the Plans.

(5) Measurement Class 5. Measurement will be by the square yard of surface area in the completed and accepted position. The surface area of the base course will be based on the width of flexible base as shown on the Plans.

Measurement Class 5 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 is required, additional measurements or calculations will not be required. No payment will be made for thickness or width exceeding that shown on the typical section or provided on the Plans.

247.5. 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 "Flexible Base (Complete in Place)" of the type, grade and measurement class specified; for "Flexible Base (Roadway Delivery)" of the type, grade and measurement class specified; and for "Flexible Base (Stockpile Delivery)" of the type, grade and measurement class specified. This price shall be full compensation for securing and furnishing all materials, including royalty and freight involved; for furnishing scales and labor involved in weighing the material when required; for loosening, blasting, excavating, screening, crushing and temporary stockpiling when required; for loading all materials; for all hauling and delivering and for all manipulations; sprinkling; for rolling, except for proof rolling; sprinkling for dust control, for labor, tools and incidentals necessary to complete the work except as follows:

When the Plans specify "Flexible Base (Complete in Place)", the unit price bid shall be full compensation for shaping and fine grading the roadbed and for spreading, mixing, blading, compacting, shaping, finishing, and curing the base material.

When the Plans specify "Flexible Base (Roadway Delivery)", the unit price bid will not include processing at the roadway. Measurement will be only by Measurement Class 1 or 2.

When the Plans specify "Flexible Base (Stockpile Delivery)", the unit price bid also will be full compensation for preparing the stockpile area and for spreading and shaping the material in the stockpile. Measurement will be only by Measurement Class 1, 2, or 3.

When proofrolling is shown on the Plans, and when directed by the City, it will be considered subsidiary to the various bid items.

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

CITY OF SAN ANGELO

ITEM 251

REWORKING BASE MATERIAL

251.1 DESCRIPTION.

This Item shall govern for reworking existing base material (with or without an asphaltic concrete pavement) in accordance with the requirements as herein specified and as shown on the Plans. This Item shall also govern for incorporation of new base material when shown on the Plans.

251.2 TYPES OF WORK.

Reworking base material shall consist of one (1) of the following types of work.

Type A. Scarifying only.

Type B. Scarifying, Salvaging and Replacing.

Type C. Scarifying, Salvaging and Stockpiling.

Type D. Scarifying, and Reshaping.

Scarifying shall consist of loosening and breaking the existing base material.

Salvaging shall consist of removing, saving and temporarily stockpiling, if necessary, the existing base material.

Stockpiling shall consist of final storage of the salvaged base material at the location shown on the Plans or as directed by the City.

Reshaping shall consist of reworking the in-place base material with or without additional new base material.

251.3 MATERIALS.

(1) Flexible Base. New base material shall meet the material requirements of Article 247.2 for the type and grade as shown on the Plans.

(2) Water. Water shall meet the same water source requirements of Item 160.2(2).

251.4. CONSTRUCTION METHODS.

(1) General. The work shall be performed to the width and depth shown on the typical sections and as specified below for the type of work shown on the Plans:

(2) Removal of Asphaltic Concrete Pavement. When shown on the Plans, any asphaltic concrete pavement, including any accompanying surface treatment, plant-mix seal and micro-surfacing, shall be removed prior to scarifying the existing base material. The Contractor shall make any necessary provision to prevent contamination of the asphaltic material during and after removal of the asphaltic material. Removal of the asphaltic material shall be in accordance with the applicable bid items. When the existing pavement consists only of a surface treatment, it will not be removed before scarifying.

(3) Type of Work.

(a) Type A (Scarifying only). The existing base, with or without existing asphaltic concrete pavement, shall be scarified for its full width and depth, unless otherwise shown on the Plans. All material shall be broken into particles of a maximum size as approved by the City, or as shown on the Plans.

(b) Type B (Scarifying, Salvaging and Replacing).

(i) Scarifying. The existing base, with or without existing asphaltic concrete pavement, shall be cleaned of all objectionable materials by blading, brooming or other approved methods, prior to scarifying. After cleaning, the existing material shall be scarified for its full width and depth, unless otherwise shown on the Plans. However, in no case shall the underlying subgrade be disturbed. Unless otherwise shown on the Plans, the material shall be broken into particles of not more than two and one-half (2 1/2) inches in size.

(ii) Salvaging. All salvaging operations, including temporary stockpiling or windrowing, shall be conducted in such a manner as not to interfere with traffic, proper drainage or the general requirements of the work. All material shown on the Plans to be salvaged shall be kept reasonably free of soil from the subgrade or roadbed during the salvaging operation. The scarified material shall be removed from the roadbed using equipment approved by the City. The salvaged material may be placed in temporary stockpiles or windrows until sufficient subgrade has been prepared to receive the material.

(iii) Replacing.

(a.) Preparation of Subgrade. Prior to replacing the salvaged material, the subgrade shall be constructed and shaped to conform to the typical sections as shown on the Plans or as established by the City. This work shall be done in accordance with the provisions of applicable bid items.

Prior to replacing the salvaged material, when shown on the Plans and when directed by the City, the Contractor shall proofroll the roadbed in accordance with Item 216, “Rolling (Proof)”. Soft spots shall be corrected as directed by the City.

(b.) Replacement of Salvaged Material. The salvaged material shall be deposited on the prepared subgrade, sprinkled if directed, bladed, and shaped to conform to the typical sections shown on the Plans or as directed by the City.

New base material, when shown on the Plans to be mixed with the salvaged base material, shall be placed and uniformly incorporated with the salvaged material.

All areas and nests of segregated material shall be corrected or removed and replaced with satisfactory and/or new material as directed by the City. All salvaged material shall be kept reasonably free of objectionable materials during the replacing operations.

The replaced material shall conform to the compaction requirements of Article 251.5 and the grade tolerances of Article 251.6.

(4) Type C (Scarifying, Salvaging and Stockpiling).

(a) Scarifying. The existing base, with or without existing asphaltic concrete pavement, shall be cleaned of objectionable materials by blading, brooming or other approved methods, prior to scarifying. After cleaning, the existing material shall be scarified for its full width and depth, unless otherwise shown on the Plans. However, in no case shall the underlying subgrade be disturbed. Unless otherwise shown on the Plans, the material shall be broken into particles of not more than two and one half (2-1/2) inches in size.

(b) Salvaging. All salvaging operations, including temporary stockpiling or windrowing, shall be conducted in such a manner as not to interfere with traffic, proper drainage or the general requirements of the work. All material shown on the Plans to be salvaged shall be kept reasonably free of soil from the subgrade or roadbed during the salvaging operation. The scarified material shall be removed from the roadbed using equipment approved by the City. Scarified material may be placed in temporary stockpiles or windrows prior to loading into approved equipment for hauling to the final stockpile site.

(c) Stockpiling. Trash, wood, brush, stumps and other objectionable materials at the final storage (stockpile) site shall be removed and disposed of as shown on the Plans or as approved by the City prior to the stockpiling of salvaged base material. The Contractor shall prepare stockpile site and shall deliver the salvaged material to the prepared final stockpile area. The material shall be worked into a neat stockpile as shown on the Plans or as approved by the City.

(5) Type D (Scarifying and Reshaping).

(a) Preparation of Subgrade. Prior to scarifying the existing base, if required, any new subgrade shall be constructed and shaped to conform to the typical sections as shown on the Plans or as established by the City. This work shall be done in accordance with the provisions of applicable bid items.

(b) Scarifying. The existing base, with or without existing asphaltic concrete pavement, shall be cleaned of all objectionable materials by blading, brooming or other approved methods, prior to scarifying. After cleaning, the existing material shall be scarified for its full width and depth, unless otherwise shown on the Plans. However, in no case shall the underlying subgrade be disturbed. Unless otherwise shown on the Plans, the material shall be broken into particles of not more than two and one-half (2 1/2) inches in size.

(c) Reshaping. After completion of scarifying, the existing base shall be mixed and shaped to conform to the typical sections shown on the Plans. However, in no case, shall the underlying subgrade be disturbed.

New base material, when shown on the Plans to be mixed with the scarified material, shall be placed on the existing scarified material, and uniformly incorporated.

The reshaped material shall conform to the compaction requirements of Article 251.3 and the grade tolerances of Article 251.6.

251.5 COMPACTION METHODS.

(1) General. The base material shall be compacted either by "Ordinary Compaction" or "Density Control" as shown on the Plans.

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

The material shall be sprinkled and rolled as directed by the City. Compaction equipment shall be approved by the City. All irregularities, depressions or weak spots which develop shall be corrected immediately by scarifying the areas and recompacting by sprinkling and rolling.

Should the material lose the required stability, compaction or finish before the next course is placed, or the project is accepted, it shall be reworked in accordance with Subarticle 251.4(4). However, compaction shall be in accordance with "Ordinary Compaction".

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

Unless otherwise shown on the Plans, each course shall be sprinkled as required and compacted to the extent necessary to provide not less than 98 percent of the optimum density as determined by TxDOT Test Method Tex-113-E / ASTM D 1557. Roadway density testing will be as outlined in TxDOT Test Method Tex-115-E / ASTM D 2922 and ASTM D 3017.

When the material fails to meet the density requirements, or should the material lose the required stability, density or finish before the next course is placed, or the project is accepted, it shall be reworked in accordance with Subarticle 251.5(4).

(4) Reworking a Section. Should the reworked base material, due to any reason or cause, lose the required stability, density or finish before the next course is placed or the project is accepted, it shall be re-compacted and refinished at the Contractor's expense.

251.6 TOLERANCES.

Tolerances shall conform to the following:

(1) Density Tolerances. The City may accept the work providing not more than one (1) out of the most recent five (5) density tests performed is below the specified density provided the failing test is no more than three (3) pounds per cubic foot below the specified density.

(2) Grade Tolerances. In areas on which pavement is to be placed, any deviation in excess of one-quarter (1/4) inch in cross section or one-quarter (1/4) inch in a length of sixteen (16) feet measured longitudinally shall be corrected by loosening, adding or removing material, reshaping and recompacting by sprinkling and rolling.

251.7 MEASUREMENT.

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

Class 1. Measurement will be by the 100-foot station measured along the centerline of each roadbed.

Class 2. Measurement will be by the square yard of the existing base or pavement in its original position. When Class 2 measurement is used, the limits of measurement will be as shown on the Plans.

This class is a plans quantity measurement 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. No payment will be made for thickness or width exceeding that shown on the typical sections or provided on the Plans.

Class 3. Measurement will be by the cubic yard of salvaged material in vehicles as delivered at the stockpile.

Class 4. Measurement will be by the cubic yard of salvaged material measured by the average-end-area method in the stockpile.

Class 5. Measurement will be by the cubic yard in its original position measured by the average-end-area method.

This class is a plans quantity measurement 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. No payment will be made for thickness or width exceeding that shown on the typical sections or provided on the Plans.

Class 6. Measurement will be by the ton of 2,000 pounds dry weight as delivered at the stockpile. When the Plans indicate that measurement of the material is to be by the ton, a set of standard platform truck scales shall be furnished by the Contractor and placed at a location

approved by the City. The dry weight will be determined by deducting the weight of the moisture from the gross weight. The moisture content in the material will be determined by Test Method Tex-103-E / ASTM D 2216, from samples taken at the time of truck weighing, at least once each day and more often if conditions warrant.

251.8 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 "Reworking Base Material" of the type, class, scarified depth, and compaction method shown on the Plans, together with the following conditions.

Measurement and payment for "Reworking Base Material (Type A)" will be restricted to Class 1, 2.

Measurement and payment for "Reworking Base Material (Type B)" will be restricted to Class 1, 2, or 5.

Measurement and payment for "Reworking Base Material (Type C)" will not be restricted to any Class.

Measurement and payment for "Reworking Base Material (Type D)" will be restricted to Class 1, 2, or 5.

The unit price bid shall be full compensation for furnishing all labor, tools, equipment, materials, supplies, and incidentals necessary to complete the work, except as follows:

When new base material is mixed with the existing base material, furnishing and delivery of the new base will be paid for as "Flexible Base (Roadway Delivery)" for the type, grade, and class shown on the Plans, in accordance with Article 247.5. All manipulation including mixing, spreading, blading, shaping and finishing of the new and existing base material will not be paid for directly, but will be considered subsidiary to this Item.

When "Ordinary Compaction" is shown on the Plans, all sprinkling and rolling and proofrolling will be considered subsidiary to this Item, unless otherwise shown on the Plans.

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

When proofrolling is shown on the Plans and when directed by the City, it will be considered subsidiary to the various Items.

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

Removal of any asphaltic material will be paid for in accordance with the applicable bid items.

*When Subgrade is not constructed on this project, corrections or soft spots will be in accordance with General Requirements and Covenants.

CITY OF SAN ANGELO

ITEM 260

LIME TREATMENT FOR MATERIALS USED AS SUBGRADE

260.1 DESCRIPTION.

This Item shall govern for treating the new or existing subgrade, the existing pavement structure or a combination thereof to be used as subgrade by pulverizing, adding lime, mixing, and compacting the mixed material as specified in this Item. Lime treatment will be required for all materials used as subgrade with a Plasticity Index (PI) greater than twenty (20) or another alternative method approved by the City.

260.2 MATERIALS.

(1) Lime. The lime shall meet the requirements of Item 264, "Lime and Lime Slurry", for the type of lime specified.

The Contractor shall have the option of selecting from the types shown on the Plans, the type of lime to be used. The City shall be notified in writing before changing the source or type.

All lime slurries used in "Slurry Placing" shall be furnished at or above the minimum "Dry Solids" content as approved by the City.

(2) Water. Water shall conform to the same water source requirements of Item 160.2(2).

(3) Asphalt. Asphalt shall conform to the requirements of Item 300, "Asphalts, Oils, and Emulsions".

260.3 EQUIPMENT.

(1) General. The machinery, tools and equipment necessary for proper prosecution of the work on this Item shall be on the project and approved by the City prior to beginning this Item.

All machinery, tools and equipment used shall be maintained in a satisfactory working condition.

(2) Lime Storage. Both quicklime and hydrated lime in dry form shall be suitably stored in closed, weatherproof containers until immediately before use. Storage bins, when used, shall be completely enclosed. Hydrated lime in bags shall be stored in weatherproof buildings with adequate protection from ground dampness. Type C Quicklime, when permitted by the City, shall be shipped only in bulk; bagged material will not be acceptable.

(3) Lime Weight Verification. When lime is furnished in trucks, the weight of lime shall be determined on certified scales or the Contractor shall provide a set of standard platform truck scales at a location approved by the City.

When Type A Hydrated Lime is furnished in bags, each bag shall bear the manufacturer's certified weight. Bags varying more than five (5) percent from that weight may be rejected and the average weight of bags in any shipment, as shown by weighing ten (10) bags taken at random, shall not be less than the manufacturer's certified weight.

(4) Slurry Equipment. Type C Quicklime of Grade "DS" or "S", when used to manufacture slurry on the project, or other location approved by the City shall be slurried in agitated slurry tanks. The slurring of Type C Quicklime must be handled in such a way as not to generate any dust hazardous to job personnel or to the public or be potentially damaging to any adjacent property.

The distributor truck used for slurry placing need not necessarily be equipped with an agitator; however, the slurry at time of distribution must meet the consistency requirements specified. The Contractor shall, if necessary, use appropriate equipment to achieve the consistency requirements under Section 260.4 (4)(b).

260.4 CONSTRUCTION METHODS.

(1) General. The completed course shall be uniformly treated, free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth and shall have a smooth surface.

(2) Preparation of Subgrade or Existing Base. Prior to treating existing material, it shall be shaped to conform to the typical sections, as shown on the Plans or as established by the City. This work shall be removed and will be paid for in accordance with applicable bid items.

Before pulverizing or scarifying an existing material, when shown on the Plans and when directed by the City, the Contractor shall proofroll the roadbed. Soft spots shall be corrected as directed by the City.

When the Contractor elects to use a cutting and pulverizing machine that will process the material to the plan depth, the Contractor will not be required to excavate to the secondary grade or windrow the material. This method will be permitted only if a machine is provided which will insure that the material is cut uniformly to the proper depth and which has cutters that will plane the secondary grade to a uniform surface over the entire width of the cut. The machine shall provide a visible indication of the depth of cut at all times.

In lieu of using the cutting and pulverizing machine, the Contractor shall excavate and windrow the material to expose the secondary grade to the typical sections, lines and grades as shown on the Plans or as established by the City.

(3) Pulverization. The existing pavement or base material shall be pulverized or scarified so that 100 percent shall pass the two (2) inch sieve.

(4) Application. The percentage by weight or pounds per square yard of lime to be added will be as shown on the Plans and may be varied by the City if conditions warrant.

Lime shall be spread only on that area where the mixing operations can be completed during the same working day, except as required for quicklime in Subarticle 260.4 (5).

Unless otherwise approved by the City, the lime operation shall not be started when the air temperature is below 40F and falling, but may be started when the air temperature is above 35F and rising. The temperature will be taken in the shade and away from artificial heat. Lime shall not be placed when weather conditions in the opinion of the City are unsuitable.

CAUTION: Use of the quicklime can be dangerous. Users should be informed of the recommended precautions in handling, storage, and use of quicklime.

The application and mixing of lime with the material shall be accomplished by the methods herein described as "Dry Placing" or "Slurry Placing". Type A Hydrated Lime shall be applied by "Slurry Placing" unless otherwise shown on the Plans or approved by the City. Type B Commercial Lime Slurry shall be applied by "Slurry Placing". Type C Quicklime shall be applied by "Slurry Placing" or "Dry Placing" as shown on the Plans. The method of applying Type C Quicklime may be changed if approved in writing by the City. When Type C Quicklime is used for dry placement, it shall be Grade "DS". When Type C Quicklime is used for slurry placement, it shall be either Grade "DS" or Grade "S". Grade "S" shall be used in slurry placement only.

(a) Dry Placing. The lime shall be distributed by a spreader approved by the City or by bag distribution for Type A Hydrated Lime at the rate shown on the Plans or as directed by the City.

The lime shall be distributed at a uniform rate and such a manner as to reduce the scattering of lime by wind. Lime shall not be applied when wind conditions, in the opinion of the City, are such that blowing lime becomes objectionable to adjacent property owners or dangerous to traffic.

A motor grader shall not be used to spread Type A Hydrated Lime, but may be used to spread Type C Quicklime, Grade "DS".

The material shall be sprinkled as approved by the City.

(b) Slurry Placing. When Type A Hydrated Lime is specified and slurry placement is to be used, the Type A Hydrated Lime shall be mixed with water to from slurry with a solids content approved by the City.

Type B Commercial Lime Slurry shall be delivered to the project in slurry form at or above the minimum dry solids content approved by the City. The distribution of lime at the rate(s) shown on the Plans or approved by the City shall be attained by successive passes over a measured section of roadway until the proper lime content has been secured.

When Type C Quicklime is applied as a slurry, the amount of dry quicklime shall be 80 percent of the amount shown on the Plans. The slurry shall contain at least the minimum dry solids content approved by the City. The residue from the slurring procedure shall be spread uniformly over the length of the roadway currently being processed unless otherwise approved by the City.

This residue is primarily inert material with little stabilizing value, but may contain a small amount of quicklime particles that slake slowly. A concentration of these particles could cause the compacted stabilized material to swell during slaking.

Slurry Consistency Requirements:

Slurry shall be of such consistency that it can be applied uniformly without difficulty.

When the distributor truck is not equipped with an agitator, the Contractor shall have a standby pump available on the project for agitating the lime and water as required by the City in case of undue delays in dispersing the slurry.

(5) Mixing. The mixing procedure shall be the same for "Dry Placing" or "Slurry Placing" as herein described.

During the interval between application and mixing, hydrated lime that has been exposed to the open air for a period of six (6) hours or more or to excessive loss due to washing or blowing will not be accepted for payment.

The material and lime shall be thoroughly mixed by equipment approved by the City. The material and lime shall be brought to the proper moisture content and may be left to cure one (1) to four(4) days as approved by the City or the mixing continued until a homogeneous friable mixture of material and lime is obtained.

In addition to the above, when Type C Quicklime, Grade "DS", is used under "Dry Placing", the material and lime shall be mixed as thoroughly as possible at the lime application. Sufficient moisture shall be added during the mixing to hydrate the quicklime. After mixing, and prior to compaction, the mixture of material, quicklime and water shall be moist cured for two (2) to seven (7) days, as approved by the City. After curing mixing shall continue until the pulverization requirements are met.

When shown on the Plans or approved by the City, the pulverization requirement may be waived when the material contains a substantial quantity of aggregate.

Following mixing, a sample of the material at roadway moisture will be obtained for pulverization testing. All non-slaking aggregates retained on the ¾-inch sieve will be removed from the sample. The remainder of the material shall meet the following pulverization requirement when tested by TxDOT Test Method Tex-101-E, Part III / ASTM D 421:

	Percent
Minimum passing 1-3/4" sieve	100
Minimum passing 3/4" sieve	85

(6) Compaction Methods. Prior to compaction, the material shall be aerated or sprinkled as necessary to provide the optimum moisture. Compaction of mixture shall begin immediately after the pulverization requirement is met.

Compaction shall continue until the entire depth of the mixture is uniformly compacted by "Ordinary Compaction" or "Density Control" as shown on the Plans. Throughout this entire operation the shape of the course shall be maintained by blading, and the surface upon completion shall be smooth and in conformity with the typical sections, lines and grades as shown on the Plans or as established by the City.

When shown on the Plans or approved by the City, multiple lifts will be permitted.

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

The material shall be sprinkled and rolled as directed by the City. All irregularities, depressions or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding or removing material as required, reshaping and recompacting by sprinkling and rolling.

Should the material lose the required stability, compaction or finish before the next course is placed or the project is accepted, it shall be reworked in accordance with Subarticle 260.4 (7). However, compaction shall be in accordance with "Ordinary Compaction".

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

Unless otherwise shown on the Plans, each course shall be sprinkled as required and compacted to the extent necessary to provide not less than 95 percent of the optimum density as determined by Test Method Tex-121-E, Part II / ASTM D 1633. Roadway density testing will be as outlined in Test Method Tex-115-E / ASTM D 2922 and ASTM D 3017.

When the material fails to meet the density requirements, or should the material lose the required stability, density or finish before the next course is placed, or the project is accepted, it shall be reworked in accordance with Subarticle 260.4(7).

(7) Reworking a Section. When a section is reworked within 72 hours after completion of compaction, the Contractor shall rework the section to provide the required compaction. When a section is reworked more than 72 hours after completion of compaction, the Contractor shall add 25 percent of the specified rate of lime. Reworking shall include loosening, road mixing as approved by the City, compacting, and finishing. When a section is reworked, a new optimum density will be determined from the reworked material in accordance with Test Method Tex-121-E, Part II / ASTM D 1633.

(8) Finishing and Curing. After the final layer or course of the lime treated material has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections.

The completed section shall then be finished by rolling with a pneumatic tire or other suitable roller as approved by the City. The completed section shall be moist cured or prevented from drying by addition of an asphalt material at the rate of 0.05 to 0.20 gallons per square yard as determined by the City. This material shall be the type shown on the Plans. Curing shall

continue for seven (7) days before further courses are added or traffic is permitted, unless otherwise approved by the City.

However, the lime treated material may be covered by other courses, the day following finishing, when approved by the City. When the Plans provide for the treated material to be covered by other courses of material, the next course shall be applied within 14 calendar days after final compaction is completed, unless otherwise approved by the City.

250.5 TOLERANCES.

Tolerances shall conform to the following:

(1) Density Tolerances. The City may accept the work providing not more than one (1) out of the most recent five (5) density tests performed is below the specified density, provided the failing test is no more than three (3) pounds per cubic foot below the specified density.

(2) Grade Tolerances. Finished grade tolerances shall be in accordance with Subarticle 132.3(2).

260.6 MEASUREMENT.

This Item will be measured as follows:

(1) Lime.

(a) Type A.

(i) Hydrated Lime (Dry). When Type A Hydrated Lime is used under "Dry Placing", the quantity of lime will be measured by the ton of 2,000 pounds, dry weight.

(ii) Hydrated Lime (Slurry). When Type A Hydrated Lime is used under "Slurry Placing", the quantity of lime will be measured by the ton of 20,00 pounds, dry weight of the hydrated lime used to prepare the lime slurry at the job site.

(b) Type B.

Commercial Lime Slurry. When Type B Commercial Lime Slurry is used, the quantity of lime will be calculated from the minimum percent "Dry Solids Content" of the slurry previously agreed upon for the project by the Contractor and City. This figure will be multiplied by the weight of the slurry in tons delivered, which must be at or above the required minimum "Dry Solids Content".

(c) Type C.

(i) Quicklime (Dry). When Type C Quicklime is used under "Dry Placing", the quantity of lime will be measured by the ton of 2,000 pounds, dry weight of the quicklime actually delivered on the road.

(ii) Quicklime (Slurry). When Type C Quicklime is used under "Slurry Placing", the quantity of lime will be measured by the ton of 2,000 pounds, dry weight of the quicklime used to prepare the hydrated lime slurry. The measured tonnage of Type C Quicklime will be multiplied by a conversion factor of 1.28 to give the quantity of equivalent hydrated lime, which will be the basis of payment.

(2) Lime Treatment. Lime treatment will be measured by the square yard of the depth specified to the lines and grades shown on the typical sections.

260.7 PAYMENT.

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for as follows:

(1) Lime. Lime will be paid for at the unit price bid for "Lime" of one of the following specified types, which price will be full compensation for furnishing all lime.

(a) Type A (Dry)

(b) Type A (Slurry)

(c) Type B

(d) Type C (Dry)

(e) Type C (Slurry)

Lime for reworking a section in accordance with Subarticle 260.4(7) will not be paid for directly but will be subsidiary to this Item.

(2) Lime Treatment. "Lime Treated Subgrade (Ordinary Compaction)" or "Lime Treated Subgrade (Density Control)" of the depth specified will be paid for at the unit price bid per square yard. This price shall be full compensation for shaping existing material, loosening, mixing, pulverizing, spreading, drying, applying lime, water content of the slurry, compacting, curing including curing materials, shaping and maintaining, processing, hauling, reworking if required, preparing secondary subgrade, and for all mixing water, tools, equipment, labor, and incidentals necessary to complete the work.

When proofrolling is shown on the Plans and directed by the City, it will not be paid for but will be subsidiary to this bid Item.

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

When "Density Control" is shown on the Plans, all sprinkling and rolling, except proofrolling, will not be paid for directly but will be considered subsidiary to this Item.

CITY OF SAN ANGELO

ITEM 264

LIME AND LIME SLURRY

264.1. DESCRIPTION.

This Item establishes the requirements for hydrated lime, quicklime and commercial lime slurry

CAUTION: Use of quicklime can be dangerous. Users should become informed of the recommended precautions in the handling, storage and use of quicklime.

264.2. TYPES.

The various types and grades are defined and identified as follows:

(1) Type A, Hydrated Lime, a dry powdered material consisting essentially of calcium hydroxide.

(2) Type B, Commercial Lime Slurry, a liquid mixture of essentially hydrated lime solid and water in slurry form.

(3) Type C, Quicklime, a dry material consisting essentially of calcium oxide. It shall be furnished in either of two grades which differ is sizing.

Grade DS, "pebble" quicklime of a gradation suitable for use in the preparation of a slurry for "Wet Placing".

Grade S, finely graded quicklime for use in the preparation of slurry for wet placing. (Note: Due to the possibility of appreciable amounts of finely divided, powdered quicklime being present in this product, the use of Type C, Grade S Quicklime is restricted to "Slurry Placing" only. It is considered to be unsuitable for "Dry Placing".

264.3. GENERAL:

Lime shall be applied as provided for in the governing specifications, as a dry material or as a mixture of lime solids and water in the form of lime slurry.

For dry application, Type A Hydrated Lime or Type C, Quicklime of Grade DS only may be used where specifications permit.

For wet application, lime slurry may be delivered to the job site as Type B, Commercial Lime Slurry or a lime slurry may be prepared at the job site or other location approved by the City, by using Type A Hydrated Lime of Type C Quicklime as specified.

The lime and lime slurry being furnished under the terms of this specification shall, in addition to all other requirements, also meet the following chemical and physical requirements.

Chemical and Physical Requirements for Lime and Lime Slurry

Chemical:	**Type**		
	A	**B**	**C**
Total "active" lime content, % by wt (i.e., % by wt Ca(OH)2 + % by wt CaO, if present)	90.0 min*	87.0 min**	-
Unhydrated lime content, % by wt CaO:	5.0 max	-	87.0 min
"Free Water" content, % by wt H2O:	5.0 max	-	-
Physical:			
Wet sieve requirement, as % by wt residue:			
Retained on No. 6 (3360 Micron) sieve:	0.2 max	0.2 max**	8.0 max***
Retained on No. 30 (590 micron) sieve:	4.0 max	4.0 max**	-
Dry sieve requirement, as % by wt residue:			
Retained on a 1-inch (25 mm) sieve:	-	-	-
Retained on a 3/4 inch (19.0) mm sieve:	-	-	10.0 max
Retained on a No. 100 (150 micron) sieve:	-	-	Grade DS-80% min Grade S-No Limits

Note * No more then 5.0% by weight CaO (unhydrated lime) will be allowed in determining the total "active" lime content.

Note ** In "solids content" of the slurry.

Note *** The amount of total "active" lime content, as CaO, in material retained on the No. 6 sieve must not exceed 2.0 percent by weight of the original Type C lime.

Type B, Commercial Lime Slurry or a slurry prepared at the job site from Type A Hydrated Lime or Type C Quicklime shall be furnished at or above the minimum "Dry Solid" content as approved by the City and must be of a consistency that can be handled and uniformly applied without difficulty. The slurry shall be free of liquids other than water and any materials of a nature injurious or objectionable for the purpose intended.

264.4 SAMPLING AND TESTING.

The sampling and testing of lime shall be determined by test Method Tex-600-J, "Lime Testing Procedure" / NA.

264.5 MEASUREMENT AND PAYMENT.

Lime will be measured and paid for in accordance with the governing specifications for the items of construction in which lime is used.

CITY OF SAN ANGELO

ITEM 275

PORTLAND CEMENT TREATED MATERIALS (ROAD MIXED)

275.1 DESCRIPTION.

This Item shall govern for treating subgrade, new and/or existing base (with or without asphaltic concrete pavement (ACP)), or combinations as shown on the Plans, by the addition of Portland cement and for road mixing and compacting the treated material to the required density, as herein specified and in conformity with the typical sections, lines, grades and thickness as shown on the Plans or as established by the City. Portland Cement treatment may be required for all materials used on subgrade with a Plasticity Index (PI) less than six (6) or another alternative method approved by the City.

275.2 MATERIALS.

Materials shall conform to the requirements shown on the Plans and to the following requirements.

(1) Flexible Base. New base material shall conform to the material requirements of Item 247, "Flexible Base" and shall be of the type and grade as shown on the Plans.

(2) Portland Cement. Portland cement shall be either Type I, IP, or II conforming to the requirements of TxDOT Item 524, "Hydraulic Cement".

(3) Water. Water shall conform to the material requirements for Item 421, "Portland Cement Concrete".

(4) Asphalt. Asphalt shall conform to the material requirements of Item 300, "Asphalts, Oils and Emulsions".

275.3 EQUIPMENT.

(1) General. The machinery, tools, and equipment necessary for proper prosecution of the work shall be on the project and approved by the City prior to beginning work on this Item.

All machinery, tools, and equipment used shall be maintained in a satisfactory working condition.

275.4 MIX DESIGN.

Cement content will be selected by the City based on compressive strength tests provided by the Contractor so as to meet the strength as shown on the Plans. When Strength L, M or N is shown on the Plans, compressive strength conforming to the requirements in Table 1 will be determined

by mix design tests provided by the Contractor on laboratory prepared samples in accordance with Test Method Tex-120-E / ASTM D 1633.

When material properties or sources change, the City may require the Contractor to provide additional mix design tests and adjust the cement content as required.

TABLE 1
STRENGTH REQUIREMENTS

Strength	Minimum Design Compressive Strength	Allowable Cement Content %
Strength L	750 psi	4 - 9
Strength M	500 psi	3 - 9
Strength N	As shown on Plans	---
Strength 0	No strength specified	As shown on the Plans

275.5 CONSTRUCTION METHODS.

(1) General. The completed course shall be uniformly treated, free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth and shall have a smooth surface.

(2) Preparation of Subgrade or Existing Base. Prior to scarifying or pulverizing existing material, the subgrade or existing base shall be shaped to conform to the typical sections as shown on the Plans or as established by the City. This work shall be done in accordance with the provisions of the applicable bid Items. When shown on the Plans, any existing asphaltic concrete pavement shall be removed and paid for in accordance with the applicable bid Items.

When proofrolling is shown on the Plans and directed by the City, it will be considered subsidiary to this bid Item. The Contractor shall proofroll the road bed in accordance with Item 216, “Rolling (Proof)”, before pulverizing or scarifying existing material. Soft spots shall be corrected as directed by the City.

When the Contractor elects to use a cutting and pulverizing machine that will process the material to the plan depth, the Contractor will not be required to excavate to the secondary grade or windrow the material. This method will be permitted only if a machine is provided which will insure that the material is cut uniformly to the proper depth and which has cutters that will plane the secondary grade to a smooth surface over the entire width of the cut. The machine shall be of such design that a visible indication is given at all times that the machine is cutting to the proper depth.

In lieu of using the cutting and pulverizing machine, the Contractor shall excavate and windrow the material to expose the secondary grade to the typical sections, lines and grades as shown on the Plans or as established by the City. Then the windrowed material shall be uniformly replaced before cement is applied.

(3) Pulverization. The existing material as shown on the typical section, shall be pulverized or scarified as follows:

(a) Existing Subgrade. A minimum of 80 percent shall pass the No. 4 sieve.

NOTE: When shown on the Plans or approved by the City, this pulverization requirement may be waived when the material contains a substantial amount of aggregate.

(**b) Subbase, Base and/or Surfacing.** A minimum of 100 percent shall pass the 2 inch sieve.

(4) Application of Cement. The percent of cement to be added will be shown on the Plans or determined in accordance with Article 275.4.

Cement shall be spread only in that area where the mixing, compacting, and finishing operations can be completed during the same working day.

Unless otherwise approved by the City, the cement treatment operation shall not be started when the air temperature is below 40 F and falling, but may be placed when the air temperature is above 35º and rising. The temperature will be taken in the shade and away from artificial heat. Cement shall not be placed when weather conditions in the opinion of the City are unsuitable.

The cement shall be spread by an approved spreader or by bag distribution. It shall be distributed at a uniform rate and in such a manner as to reduce to a minimum the scattering of cement by wind. Cement shall not be applied when wind conditions, in the opinion of the City, are such that blowing cement becomes objectionable to adjacent property owners or dangerous to traffic.

(5) Mixing. Only single or multiple soil stabilizer mixers shall be used.

When delivered flexible base is shown on the Plans, the base materials shall be uniformly spread and premixed prior to the addition of cement or water, unless otherwise approved by the City.

After any required mixing of the material(s), the cement shall be dry mixed with the material(s), prior to the addition of water. Immediately after dry mixing, water shall be uniformly applied. After mixing, the mixture shall be in a loose, evenly spread state ready for compaction. The mixture shall be mixed and compacted in one lift.

(6) Compaction Methods. Compaction shall continue until the entire thickness of the mixture is uniformly compacted by “Ordinary Compaction” or “Density Control” as shown on the Plans.

Compaction shall be completed within two (2) hours of the addition of water to the dry mixed material.

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

The treated material shall be sprinkled and rolled as directed by the City. All irregularities, depressions or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding or removing treated material as required, reshaping, and recompacting at the Contractor's expense.

Should the material lose the required stability, compaction or finish before the next course is placed or the project is accepted, it shall be removed and replaced, unless otherwise approved by the City. Removal and replacement will be at the Contractor's expense.

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

Unless otherwise shown on the Plans, the course shall be sprinkled as required herein and compacted to the extent necessary to provide not less than 95 percent of the density as determined by Test Method Tex-120-E, Part II / ASTM D 1633. Roadway density will be determined by Test Method Tex-115-E / ASTM D 2922 & ASTM D 3017.

(7) Finishing. Immediately after compaction, the surface of the mixture shall be clipped, skinned, or tight bladed by a maintainer or subgrade trimmer to a depth of approximately 1/4", removing all loosened materials. The loosened materials shall be disposed of at the Contractor's expense and at a location approved by the City. The surface shall then be rolled with a pneumatic tire roller, adding small increments of moisture as needed during rolling.

Throughout this operation, the shape of the course shall be maintained and the surface upon completion shall be smooth and in conformity with the typical sections, lines and grades as shown on the Plans or as established by the City.

(8) Curing. The completed section shall be moist cured for three days or prevented from drying by addition of an asphalt material at the rate of 0.05 to 0.20 gallon per square yard as determined by the City. The asphalt used shall be of the type and grade shown as on the Plans or as approved by the City.

275.6 TOLERANCES.

Tolerances shall conform to the following:

(1) Density Tolerances. The City may accept the work providing not more than one (1) out of the most recent five (5) density tests performed is below the specified density, provided the failing test is no more than three (3) pounds per cubic foot below the specified density.

(2) Moisture Tolerances. The percentage of moisture in the mixture at the beginning of compaction shall be within plus or minus two (2) percentage points of optimum as determined by

Test Method Tex-120-E, Part II / ASTM D 1633, unless otherwise approved by the City. The percent of moisture will be determined in accordance with Test Method Tex-103-E / ASTM D 2216. If the percentage of moisture is outside the allowable tolerance, the Contractor shall adjust operations to meet this requirement.

(3) Grade Tolerances. In areas on which pavement is to be placed, any deviation in excess of 1/4 inch in cross section and 1/4 inch in 16 feet measured longitudinally shall be corrected by loosening, adding, or removing material, reshaping, and compacting by sprinkling and rolling.

275.7 MEASUREMENT.

This Item will be measured as follows:

Cement Treatment will be measured by the square yard of the surface area to the lines and grades shown on the typical sections.

Cement will be measured by the ton of 2,000 pounds, dry weight.

275.8 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 "Cement Treatment (Existing Material)", "Cement Treatment (New Base)", or "Cement Treatment (Mixing Existing Material and New Base)" of the strength, thickness and compaction method specified and for "Cement" at the unit price bid per ton of 2,000 pounds, dry weight. This price shall be full compensation for shaping existing material, loosening, pulverizing, providing cement, spreading, road mixing, compacting, blading, shaping, finishing, curing including curing materials, replacing if required, and for all mixing water, labor, tools and incidentals necessary to complete the work except as otherwise provided for in this Item.

When new base material is shown on the Plans, furnishing and delivery of the new base will be paid for as "Flexible Base (Roadway Delivery)", of the type, grade and class shown on the Plans in accordance with Item 247.5.

When "Ordinary Compaction" is shown on the Plans, all sprinkling and rolling, and proofrolling will be considered subsidiary to this Item, unless otherwise shown on the Plans.

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

When proofrolling is specified by the City and shown on the Plans, it will be considered subsidiary to this bid Item.

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

CITY OF SAN ANGELO

ITEM 300

ASPHALTS, OILS, AND EMULSIONS

300.1. DESCRIPTION.

This Item shall for govern providing asphalt cements, cutback and emulsified asphalts, performance-graded asphalt binders, and other miscellaneous asphalt materials as specified on the plans.

300.2. MATERIALS.

Provide asphalt materials that meet the stated requirements when tested in accordance with the referenced Department, AASHTO, and ASTM test methods. Acronyms used in this Item are defined in Table 1

TABLE 1
ACRONYMS

Acronym	Definition
Test Procedure Designations	
Tex T or R D	Department AASHTO ASTM
Polymer Modifier Designations	
P SBR or L SBS TR	Polymer-modified Styrene-butadiene rubber (latex) Styrene- butadiene-styrene block co-polymer Tire rubber (from ambient temperature Grinding of truck and passenger tires)
AC	Asphalt cement
AE	Asphalt emulsion
AE-P	Asphalt emulsion prime
A-R	Asphalt-rubber
C	Cationic
EAP&T	Emulsified asphalt prime and tack
H-suffix	Harder residue (lower penetration)
HF	High float
MC	Medium-curing
PCE	Prime, cure and erosion control

TABLE 1 (Continued)
ACRONYMS

Acronym	Definition
MS	Medium-setting
PG	Performance grade
RC	Rapid-curing
RS	Rapid-setting
S-suffix	Stockpile usage
SCM	Special cutback material
SS	Slow-setting

(1) Asphalt Cement. Asphalt cement must be homogeneous, water-free, and nonfoaming when heated to 347 ºF, and must meet Table 2 requirements.

TABLE 2
ASPHALT CEMENT

Property	Test Procedure	Viscosity Grade									
		AC-0.6		AC-1.5		AC-3		AC-5		AC-10	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity 140 ºF, poise 275 ºF, poise	T 202	 40 0.4	 80 -	 100 0.7	 200 -	 250 1.1	 350 -	 400 1.4	 600 -	 800 1.9	 1,200 -
Penetration, 77 ºF, 100g, 5 sec.	T 49	350	-	250	-	210	-	135	-	85	-
Flash point, C.O.C., ºF	T 48	425	-	425	-	425	-	425	-	450	-
Solubility in trichloroethylene, %	T 44	99.0	-	99.0	-	99.0	-	99.0	-	99.0	-
Spot test	Tex-509-C	Neg.		Neg.		Neg.		Neg.		Neg.	
Tests on residue from Thin-Film Oven Test: Viscosity, 140 ºF, poise Ductility[1], 77 ºF 5 cm/min., cm	T 179 T 202 T 51	 - 100	 180 -	 - 100	 450 -	 - 100	 900 -	 - 100	 1,500 -	 - 100	 3,000 -

1. If AC-0.6 or AC 1-5 ductility at 77 ºF is less than 100 cm, material is acceptable if ductility at 60 ºF is more than 100 cm.

(2) Polymer-Modified Asphalt Cement. Polymer-modified asphalt cement must be smooth and homogeneous, and comply with the requirements of Table 3. If requested, supply samples of the base asphalt cement and polymer additives.

TABLE 3
POLYMER-MODIFIED ASPHALT CEMENT

Property	Test Procedure	Polymer-Modified Viscosity Grade							
		AC-5 w/2% SBR		AC-10 w/2% SBR		AC-15P		AC-20-5TR	
		Min	Max	Min	Max	Min	Max	Min	Max
Polymer		SBR		SBR		SBS		TR	
Polymer content, % (solid basis)	Tex-533-C	2.0	-	2.0	-	3.0	-	5.0	-
Dynamic shear, G*/sin.õ, 64ºC, 10 rad/s, kPa	T 315	-	-	-	-	-	-	1.0	-
Viscosity									
140ºF, poise	T 202	700	-	1,300	-	1,500	-	2,000	-
275ºF, poise	T 202	-	7.0	-	80	-	8.0	-	10.0
Penetration, 77ºF, 100g, 5 sec.	T 49	120	-	80	-	100	150	75	115
Ductility, 5cm/min., 39.2ºF, cm	T 51	70	-	60	-	-	-	-	-
Elastic recovery, 50ºF, %	Tex-539-C	-	-	-	-	55	-	55	-
Softening point, ºF	T 53	-	-	-	-	-	-	120	-
Polymer separation, 48 hr.	Tex-540-C	None		None		None		None	
Flash point, C.O.C., ºF	T 48	425	-	425	-	425	-	425	-
Tests on residue from Thin-Film Over Test:	T 179								
Retained penetration ratio, 77ºF	T 49	-	-	-	-	0.60	1.00	0.60	1.00
Tests on residue from RTFOT aging and pressure aging:									
Creep stiffness	Tex-541-C								
S, 18ºC, MPa	and R 28	-	-	-	-	-	-	-	300
m-value, 18ºC	T 313	-	-	-	-	-	-	0.300	-

(3) Cutback Asphalt. Cutback asphalt must meet the requirements of Tables 4, 5, and 6 for the specified type and grade. If requested, supply samples of the base asphalt cement and polymer additives.

TABLE 4

RAPID-CURING CUTBACK ASPHALT

Property	Test Procedure	Type-Grade					
		RC-250		RC-800		RC-3000	
		Min	Max	Min	Max	Min	Max
Kinematic viscosity, 140ºF, cSt	T 201	250	400	800	1,600	3,000	6,000
Water, %	T 55	-	0.2	-	0.2	-	0.2
Flash point, T.O.C., ºF	T 79	80	-	80	-	80	-
Distillation test:	T 78						
Distillate, percentage by volume of total distillate							
to 680ºF		40	75	35	70	20	55
to 437ºF		65	90	55	85	45	75
to 500ºF		85	-	80	-	70	-
to 600ºF		70	-	75	-	82	-
Residue from distillation, V %							
Tests on distillation residue:							
Penetration, 100 g, 5 sec. 77ºF	T 49	80	120	80	120	80	120
Ductility, 5 cm/min., 77ºF, cm	T 51	100	-	100	-	100	-
Solubility in trichloroethylene, %	T 44	99.0	-	99.0	-	99.0	-
Spot test	Tex-509-C	Neg.		Neg.		Neg.	

TABLE 5

MEDIUM-CURING CUTBACK ASPHALT

Property	Test Procedure	Type-Grade							
		MC-30		MC-250		MC-800		MC-3000	
		Min	Max	Min	Max	Min	Max	Min	Max
Kinematic viscosity, 140ºF, cSt	T 201	30	60	250	500	800	1,600	3,000	6,000
Water, %	T 55	-	0.2	-	0.2	-	0.2	-	0.2
Flash point, T.O.C., ºF	T 79	100	-	150	-	150	-	150	-
Distillation test:	T 78								
Distillate, percentage by volume of total distillate									
to 680ºF		-	25	-	10	-	-	-	-
to 437ºF		40	70	15	55	-	35	-	15
to 500ºF		75	93	60	87	45	80	15	75
to 600ºF		50	-	67	-	75	-	80	-
Residue from distillation, V %									
Tests on distillation residue:									
Penetration, 100g, 5 sec., 77ºF	T 49	120	250	120	250	120	250	120	250
Ductility, 5cm/min., 77ºF, cm[1]	T 51	100	-	100	-	100	-	100	-
Solubility in trichloroethylene, %	T 44	99.0	-	99.0	-	99.0	-	99.0	-
Spot test	Tex-509-C	Neg.		Neg.		Neg.		Neg.	

TABLE 6
SPECIAL-USE CUTBACK ASPHALT

Property	Test Procedure	Type-Grade					
		MC-2400L		SCM I		SCM II	
		Min	Max	Min	Max	Min	Max
Kinematic viscosity, 140ºF, cSt	T 201	2,400	4,800	500	1,000	1,000	2,000
Water, %	T 55	-	0.2	-	0.2	-	0.2
Flash point, T.O.C., ºF	T 79	150	-	175	-	175	-
Distillation test:	T 78						
Distillate, percentage by volume of total distillate							
to 680ºF		-	-	-	-	-	-
to 437ºF		-	35	-	0.5	-	0.5
to 500ºF		35	80	20	60	15	50
to 600ºF		78	-	76	-	82	-
Residue from distillation, vol %							
Tests on distillation residue:							
Polymer		SBR		-		-	
Polymer content, % (solids basis)	Tex-533-C	2.0	-	-	-	-	-
Penetration, 100 g, 5 sec. 77ºF	T 49	150	300	180	-	180	-
Ductility, 5 cm/min., 39.2ºF, cm	T 51	50	-	-	-	-	-
Solubility in trichloroethylene, %	T 44	99.0	-	99.0	-	99.0	-

(4) Emulsified Asphalt. Emulsified asphalt must be homogeneous, not separate after thorough mixing, and meet the requirements for the specified type and grade in Table 7, 8, 9, and 10.

TABLE 7

EMULSIFIED ASPHALT

Property	Test Procedure	Type-Grade									
		Rapid-Setting		Medium-Setting				Slow-Setting			
		HFRS-2		MS-2		AES-300		SS-1		SS-1H	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol	T 72										
77ºF, sec.		-	-	-	-	75	400	20	100	20	100
122ºF, sec.		150	400	100	300	-	-	-	-	-	-
Sieve test, %	T 59	-	0.1	-	0.1	-	0.1	-	0.1	-	0.1
Miscibility	T 59	-		-		-		Pass		Pass	
Cement mixing, %	T 59	-	-	-	-	-	-	-	2.0	-	2.0
Coating ability and water resistance:	T 59										
dry aggregate/after spray		-		-		Good/Fair		-		-	
wet aggregate/after spray		-		-		Fair/Fair		-		-	
Demulsibility, 35 ml of 0.02 N $CaCl_2$, %	T 59	50	-	-	30	-	-	-	-	-	-
Storage stability, 1 day, %	T 59	-	1	-	1	-	1	-	1	-	1
Freezing test, 3 cycles[1]	T 59	-		Pass		-		Pass		Pass	
Distillation test:	T 59										
Residue by distillation, % by wt.		65	-	65	-	65	-	60	-	60	-
Oil distillate, % by volume of emulsion		-	0.5	-	0.5	-	5	-	0.5	-	0.5
Tests on residue from distillation:											
Penetration, 77ºF, 100 g, 5 sec.	T 49	100	140	120	160	300	-	120	160	70	100
Solubility in trichloroethylene, %	T 44	97.5	-	97.5	-	97.5	-	97.5	-	97.5	-
Ductility, 77ºF, 5 cm/min., cm	T 51	100	-	100	-	-	-	100	-	80	-
Float test, 140ºF, sec.	T50	1,200	-	-	-	1,200	-	-	-	-	-

1. Applies only when the City designates for winter use

TABLE 8

EMULSIFIED ASPHALT

Property	Test Procedure	Type-Grade											
		Rapid-Setting				Medium-Setting				Slow-Setting			
		CRS-2		CRS-2H		CMS-2		CMS-2S		CSS-1		CSS-1H	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol	T 72												
77ºF, sec.		-	-	-	-	-	-	-	-	20	100	20	100
122ºF, sec.		150	400	150	400	100	300	100	300	-	-	-	-
Sieve Test, %	T 59	-	0.1	-	0.1	-	0.1	-	0.1	-	0.1	-	0.1
Cement mixing, %	T 59	-	-	-	-	-	-	-	-	-	2.0	-	2.0
Coating ability and water resistance:	T 59												
dry aggregate/after spray		-		-		Good/Fair		Good/Fair		-		-	
wet aggregate/after spray		-		-		Fair/Fair		Fair/Fair		-		-	
Demulsibility, 35 ml of 0.8% sodium dioctyl sulfosuccinate, %	T 59	70	-	70	-	-	-	-	-	-	-	-	-
Storage stability, 1 day, %	T 59	-	1	-	1	-	1	-	1	-	1	-	1
Particle charge	T 59	Positive		Positive		Positive		Positive		Positive		Positive	
Distillation test:	T 59												
Residue by distillation, % by wt.		65	-	65	-	65	-	65	-	60	-	60	-
Oil distillate, % by volume of emulsion		-	0.5	-	0.5	-	7	-	5	-	0.5	-	0.5
Tests on residue from distillation:													
Penetration, 77ºF, 100g, 5 sec.	T 49	120	160	70	110	120	200	300	-	120	160	70	110
Solubility in trichloroethylene, %	T 44	97.5	-	97.5	-	97.5	-	97.5	-	97.5	-	97.5	-
Ductility, 77ºF, 5 cm/min., cm	T 51	100	-	80	-	100	-	-	-	100	-	80	-

TABLE 9

POLYMER-MODIFIED EMULSIFIED ASPHALT

Property	Test Procedure	Type-Grade											
		Rapid-Setting				Medium-Setting				Slow-Setting			
		RS-1P		HFRS-2P		AES-150P		AES-300P		AES-300S		SS-1P	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol	T 72												
77ºF, sec.		-	-	-	-	75	400	75	400	75	400	30	100
122ºF, sec.		50	200	150	400	-	-	-	-	-	-	-	-
Miscibility	T 59	-		-		-		-		-		Pass	
Coating ability and water resistance:	T 59												
dry aggregate/after spray		-		-		Good/Fair		Good/Fair		Good/Fair		-	
wet aggregate/after spray		-		-		Fair/Fair		Fair/Fair		Fair/Fair		-	
Demulsibility, 35 ml of 0.02 N $CaCl_2$, %	T 59	60	-	50	-	-	-	-	-	-	-	-	-
Storage stability, 1 day,	T 59	-	1	-	1	-	1	-	1	-	1	-	1
Breaking index, g	Tex-542-	-	80	-	-	-	-	-	-	-	-	-	-
Distillation test:[1]	T 59												
Residue by distillation, % by wt,		65	-	65	-	65	-	65	-	65	-	60	-
Oil distillate, % by volume of emulsion		-	3	-	0.5	-	3	-	5	-	7	-	0.5
Tests on residue from distillation:													
Polymer content, wt. % (solids basis)	Tex-533-C	-	-	3.0	-	-	-	-	-	-	-	3.0	-
Penetration, 77ºF, 100 g, 5sec	T 49 T 44	225	300	90	140	150	300	300	-	300	-	100	140
Solubility in	T 202	97	-	97	-	97	-	97	-	97	-	97	-
trichloroethylene, %	T 50	-	-	1,500	-	-	-	-	-	-	-	1,300	-
Viscosity, 140ºF, poise	T 51	-	-	1,200	-	1,200	-	1,200	-	1,200	-	-	-
Float test, 140ºF, poise		-	-	50	-	-	-	-	-	-	-	50	-
Ductility[2], 39.2ºF, 5 cm/min., cm	Tex-539-C												
Elastic recovery[2], 50°F, %		55	-	55	-	-	-	-	-	-	-	-	-
Tests on RTFO curing of distillation residue	Tex-541-C												
Elastic recovery, 50°F, %	Tex-539-C	-	-	-	-	50	-	50	-	30	-	-	-

1. Exception to T 59: Bring the temperature on the lower thermometer slowly to 350°F ± 10°F. Maintain at this temperature for 20 min. Complete total distillation in 60 ± 5 min. from the first application of heat.
2. HFRS-2P must meet one of either the ductility or elastic recovery requirements.

TABLE 10

POLYMER-MODIFIED CATIONIC EMULSIFIED ASPHALT

Property	Test Procedure	Type-Grade					
		CRS-1P		CRS-2P		CSS-1P	
		Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol	T 72						
77°F, sec.		-	-	-	-	20	100
122°F, sec.		50	150	150	400	-	-
Sieve test, %	T 59	-	0.1	-	0.1	-	0.1
Demulsibility, 35 ml of 0.8% sodium	T 59	60	-	70	-	-	-
Storage stability, 1 day %	T 59	-	1	-	1	-	1
Breaking index, g	Tex-542-C	-	80	-	-	-	-
Particle charge	T 59	Positive		Positive		Positive	
Distillation test:[1]	T 59						
Residue by distillation, % by wt		65	-	65	-	62	-
Oil distillate, % by vol of emulsion		-	3	-	0.5	-	0.5
Tests on residue from distillation:							
Polymer content, wt. % (solids basis)	Tex-533-C	-	-	3.0	-	3.0	-
Penetration, 77°F, 100 g, 5 sec.	T 49	225	300	90	150	55	90
Viscosity, 140°F, poise	T 202	-	-	1,300	-	-	-
Solubility in trichloroethylene, %	T 44	97.0	-	97.0	-	97.0	-
Softening point, °F	T 53	-	-	-	-	135	-
Ductility, 77°F, 5 cm/min., cm	T 51	-	-	-	-	70	-
Ductility[2], 39.2°F, 5 cm/min., cm	T 51	-	-	50	-	-	-
Elastic recovery[2], 50°F, %	Tex-539-C	45	-	55	-	-	-

1. Exception to T 59: Bring the temperature on the lower thermometer slowly to 350°F ±0°F. Maintain at this temperature for 20 min. Complete total distillation in 60 ± 5 min. from the first application of heat.
2. CRS-2P must meet one of either the ductility or elastic recovery requirements.

(5) Specialty Emulsions. Specialty emulsions may be either asphalt-based or resin-based and must meet the requirements of Table 11.

TABLE 11

SPECIALTY EMULSIONS

Property	Test Procedure	Type-Grade					
		Medium-Setting				Slow-Setting	
		AE-P		EAP&T		PCE[1]	
		Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol	T 72						
77°F, sec.		-	-	-	-	10	100
122°F, sec.		15	150	-	-	-	-
Sieve test, %	T 59	1	0.1	-	0.1	-	0.1
Miscibility°[2]	T 59	0		Pass		Pass	
Demulsibility, 35 ml of 0.10 N $CaCl_2$%	T 59	-	70	-	-	-	-
Storage stability, 1 day, %	T 59	-	1	-	1	-	-
Particle size[5], % by volume, < 2.5	Tex-238-	-	-	90	-	90	-
Asphalt emulsion distillation to 500ºF followed by Cutback asphalt distillation of residue to 680ºF:	T 59 & T 78						
Residue after both distillations, % by wt.		40	-	-	-	-	-
Total oil distillate from both distillations, % by vol of emulsion		25	40	-	-	-	-
Residue by distillation, % by wt.	T 59	-	-	60	-	-	-
Residue by evaporation[4], % by wt.	T 59	-	-	-	-	60	-
Tests on residue after all distillation(s):							
Viscosity, 140ºF, poise	T 202	-	-	800	-	-	-
Kinematic viscosity[5], 140ºF, cSt	T 201	-	-	-	-	100	350
Flash point C.O.C., ºF	T 48	-	-	-	-	400	-
Solubility in trichloroethylene, %	T 44	97.5	-	-	-	-	-
Float test, 122ºF, sec.	T 50	50	200	-	-	-	-

1. Supply with each shipment of PCE:
   a) a copy of a lab report from an approved analytical lab, signed by a lab official, indicating the PCE formulation does not meet any characteristics of a Resource Conservation Recovery Act (RCRA) hazardous waste;
   b) a certification from the producer that the formulation supplied does not differ from the one tested and that no listed RCRA hazardous wastes on PCBs have been mixed with the product; and
   c) a Material Safety Data Sheet.
2. Exception to T 59; In dilution, use 350 ml of distilled or deionized water and a 1,000-ml beaker.
3. Use Tex-238-F, beginning at "Particle Size Analysis by Laser Diffraction," with distilled or deionized water as a medium and no dispersant, or use another approved method.
4. Exception to T 59: Leave sample in the oven until foaming ceases, then cool and weigh.
5. PCE must meet either the kinematic viscosity requirement or the particle size requirement.

(6) Recycling Agent. Recycling agent and emulsified recycling agent must meet the requirements in Table 12. Additionally, recycling agent and residue from emulsified recycling agent, when added in the specified proportions to the recycled asphalt, must meet the properties specified on the plans.

TABLE 12
RECYCLING AGENT AND EMULSIFIED RECYCLING AGENT

Property	Test Procedure	Recycling Agent		Emulsified Recycling Agent	
		Min	Max	Min	Max
Viscosity, Saybolt Furol, 77ºF, sec.	T 72	-	-	15	100
Sieve test, %	T 59	-	-	-	0.1
Miscibility[1]	T 59	-		No coagulation	
Residue by evaporation[2], % by wt.	T 59	-	-	60	-
Tests on recycling agent or residue from evaporation:					
Flash point, C.O.C., ºF	T 48	400	-	400	-
Kinematic viscosity,	T 201				
140ºF, cSt		75	200	75	200
275ºF, cSt		-	10.0	-	10.0

1. Exception to T 59: Use 0.02 N $CaCl_2$ solution in place of water.
2. Exception to T 59: Maintain sample at 300ºF until foaming ceases, then cool and weigh.

(7) Crumb Rubber Modifier. Crumb rubber modifier (CRM) consists of automobile and truck tires processed by ambient temperature grinding.

CRM must be:

- free from contaminants including fabric, metal, and mineral and other nonrubber substance;
- free-flowing; and
- nonfoaming when added to hot asphalt binder.

When tested in accordance with Tex-200-F, Part I, using at 50-g sample, the rubber gradation must meet the requirements of the grades in Table 13.

TABLE 13
CRM GRADATIONS

Sieve Size (% Passing)	Grade A		Grade B		Grade C		Grade D	Grade E
	Min	Max	Min	Max	Min	Max		
#8	100	-	-	-	-	-	As shown on the plans	As approved
#10	95	100	100	-	-	-		
#16	-	-	70	100	100	-		
#30	-	-	25	60	90	100		
#40	-	-	-	-	45	100		
#50	0	10	-	-	-	-		
#200	-	-	0	5	-	-		

(8) Crack Sealer. Polymer modified asphalt-emulsion crack sealer must meet the requirements of Table 14. Rubber-asphalt crack sealer must meet the requirements of Table 15.

TABLE 14
POLYMER-MODIFIED ASPHALT EMULSION CRACK SEALER

Property	Test Procedure	Min	Max
Retational viscosity, 77ºF, cP	D 2196, Method A	10,000	25,000
Sieve test, %	T 59	-	0.1
Storage stability, 1 day, %	T 59	-	1
Evaporation Residue by evaporation, % by wt.	Tex-543-C	65	-
Tests on residue from evaporation: Penetration, 77ºF, 100 g, 5 sec. Softening point, ºF Ductility, 39.2ºF, 5 cm/min., cm	 T 49 T 53 T 51	 35 140 100	 75 - -

TABLE 15
RUBBER-ASPHALT CRACK SEALER

Property	Test Procedure	Class A		Class B	
		Min	Max	Min	Max
CRM content, Grade A or B, % by wt.	Tex-544-C	22	26	-	-
CRM content, Grade B, % by wt.	Tex-544-C	-	-	13	17
Virgin rubber content[1], % by wt.		-	-	2	-
Flash point[2], COC, ºF	T 48	400	-	400	-
Penetration[3], 77ºF, 150 g, 5 sec.	T 49	30	50	30	50
Penetration[3], 32ºF, 200 g, 60 sec.	T 49	12	-	12	-
Softening point, ºF	T 53	-	-	170	-
Bond[4]	D5329	-		Pass	

1. Provide certification that the min. % virgin rubber was added.
2. Before passing the test flame over the cup, agitate the sealing compound with a 3/8-to ½-in. (9.5-to 12.7-mm) wide, square-end metal spatula in a manner so as to bring the material on the bottom of the cup to the surface, i.e., turn the material over. Start at one side of the thermometer, move around to the other, and then return to the starting point using 8 to 10 rapid circular strokes. Accomplish agitation in 3 to 4 sec. Pass the test flame over the cup immediately after stirring is completed.
3. Exception to T 49: Substitute the cone specified in ASTM D 217 for the penetration needle.
4. No crack in the crack sealing materials or break in the bond between the sealer and the mortar blocks over ¼ in. deep for any specimen after completion of the test.

(9) Asphalt-Rubber Binders. Asphalt-rubber (A-R) binders are mixtures of asphalt binder and CRM, which have been reacted at elevated temperatures. The A-R binders meet D 6114 and contain a minimum of 15% CRM by weight. Types I or II, containing CRM Grade C, are used for hot mixed aggregate mixtures. Types II and III, containing CRM Grade B, are used for surface treatment binder. Table 16 describes required binder properties.

TABLE 16
A-R BINDERS

Property	Test Procedure	Binder Type					
		Type I		Type II		Type III	
		Min	Max	Min	Max	Min	Max
Apparent viscosity, 347ºF, cP	D 2196, Method A	1,500	5,000	1,500	5,000	1,500	5,000
Penetration, 77ºF, 100 g, 5 sec.	T 49	25	75	25	75	50	100
Penetration, 39.2ºF, 200 g, 60 sec.	T 49	10	-	15	-	25	-
Softening Point, ºF	T 53	135	-	130	-	125	-
Resilience, 77ºF, %	D 5329	25	-	20	-	10	-
Flash point, C.O.C., ºF	T 48	450	-	450	-	450	-
Tests on residue from Thin-Film Oven Test: Retained penetration ratio, 39.2ºF, 200 g, 60 sec., % of Original	T 179 T 49	75	-	75	-	75	-

(10) Performance-Graded Binders. PG binders must be smooth and homogeneous, show no separation when tested in accordance with Tex-540-C, and meet Table 17 requirements.

Separation testing is not required if:

- a modifier is introduced separately at the mix plant either by injection in the asphalt line or mixer,
- the binder is blended on site in continuously agitated tanks, or
- binder acceptance is based on field samples taken from an in-line sampling port at the hot mix plant after the addition of modifiers.

TABLE 17
PERFORMANCE-GRADED BINDERS

Property and Test Method	Performance Grade																					
	PG 58			PG 64				PG 70				PG 76				PG 82						
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Average 7-day max pavement design temperature, ºC[1]	< 58			<64				<70				<76				<80						
Min pavement design temperature, ºC[1]	>-22	>-28	>-34	>-16	>-22	>-28	>-34	>-16	>-22	>-28	>-34	>-16	>-22	>-28	>-34	>-16	>-22	>-28	>-34	>-16	>-22	>-28
ORIGINAL BINDER																						
Flash point, T 48, Min, ºC	230																					
Viscosity, T 316[2,3] Max, 3.0 Pa-s, test temperature,	135																					
Dynamic shear, T 315:[4] G*/sin(δ), Min. 1.00 kPa Test temperature @ 10rad/sec.ºC	58			64				70				76				82						
Elastic recovery, D 6084, 50ºF, % Min	-	-	30	-	-	30	50	-	30	50	60	30	50	60	70	50	60	70				
ROLLING THIN-FILM OVEN (Tex-541-C)																						
Mass loss, Tex-541-C, Max,	1.0																					
Dynamic shear, T 315: G*/sin(δ), Min, 2.20 kPa Test temperature @ 10rad/sec., ºC	58			64				70				76				82						
PRESSURE AGING VESSEL (PAV) RESIDUE (R 28)																						
PAV aging temperature, ºC	100																					
Dynamic shear, T 315: G*/sin(δ), Max, 5000 kPa Test temperature @ 10 rad/sec., ºC	25	22	19	28	25	22	19	28	25	22	19	28	25	22	19	28	25	22				
Creep stiffness, T 313:[5,6] S, max, 300 MPa, m-value, min, 0.300 Test temperature @ 60 sec., ºC	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18				
Direct tension, T 314:[6] Failure strain, min, 1.0% Test temperature @ 1.0 mm/min., ºC	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18				

1. Pavement temperatures are estimated from air temperatures using an algorithm contained in a Department-supplied computer program may be provided by the Department, or by following the procedures outlined in AASHTO MP 2 and PP 28.
2. This requirement may be waived at the Department's discretion if the supplier warrants that the asphalt binder can be adequately pumped, mixed and compacted at temperatures that meet all applicable safety, environmental, and constructability requirements. At test temperatures where the binder is a Newtonian fluid, any suitable standard means of viscosity measurement may be used, including capillary (T 201 or T 202) or rotational viscometry (T 316).
3. Viscosity at 135ºC is an indicator of mixing and compaction temperatures that can be expected in the lab and field. High values may indicate high mixing and compaction temperatures. Additionally, significant variation can occur from batch to batch. Contractors should be aware that variation could significantly impact their mixing and compaction operations. Contractors are therefore responsible for addressing any constructability issues that may arise.
4. For quality control of unmodified asphalt binder production, measurement of the viscosity of the original asphalt binder may be substituted for dynamic shear measurements of G*/sin (õ) at test temperatures where the asphalt is a Newtonian fluid. Any suitable standard means of viscosity measurement may be used, including capillary (T 201 or T 202) or rotational viscometry (T 316).
5. Silicone beam molds, as described in AASHTO TP 1-93, are acceptable for use.
6. If creep stiffness is below 300 MPa, direct tension test is not required. If creep stiffness is between 300 and 600 MPa, the direct tension failure strain requirement can be used instead of the creep stiffness requirement. The m-value requirement must be satisfied in both cases.

300.3. EQUIPMENT.

Provide all equipment necessary to transport, store, sample, heat, apply, and incorporate asphalts, oils and emulsions.

300.4. CONSTRUCTION.

(1) Typical Material Use. Table 18 shows typical materials used for specific applications. These are typical uses only. Circumstances may require use of other material.

TABLE 18

TYPICAL MATERIAL USE

Material Application	Typically Used Materials
Hot-mixed, hot-laid asphalt mixtures	PG binders, A-R binders Types I and II
Surface treatment	AC-5, AC-10, AC-5 w/2% SBR, AC-10 w/2% SBR, AC-15P, AC-20-5TR, HFRS-2, MS-2, CRS-2, CRS-2H, HFRS-2P, CRS-2P, A-R binders Types II and III
Surface treatment (cool weather)	RS-1P, CRS-1P, RC-250, RC-800, RC-3000, MC-250, MC-800, MC-3000, MC-2400L
Precoating	AC-5, AC-10, PG 64-22, SS-1, SS-1H, CSS-1, CSS-1H
Tack coat	PG binders, SS-1H, CSS-1H, EAP&T
Fog seal	SS-1, SS-1H, CSS-1, CSS-1H
Hot-mixed, cold-laid asphalt mixtures	AC-0.6, AC-1.5, AC-3, AES-300, AES-300P, CMS-2, CMS-2S
Patching mix	MC-800, SCM I, SCM II, AES-300S
Recycling	AC-0.6, AC-1.5, AC-3, AES-150P, AES-300P, recycling agent, emulsified recycling agent
Crack sealing	SS-1P, polymer mod AE crack sealant, rubber asphalt crack sealers (Class A, Class B)
Microsurfacing	CSS-1P
Prime	MC-30, AE-P, EAP&T, PCE
Curing membrane	SS-1, SS-1H, CSS-1, CSS-1H, PCE
Erosion control	SS-1, SS-1H, CSS-1, CSS-1H, PCE

TABLE 19

STORAGE AND APPLICATION TEMPERATURES

Type-Grade	Application		Storage Maximum (°F)
	Recommended Range, °F	Maximum Allowable (°F)	
AC-0.6, AC-1.5, AC-3	200-300	350	350
AC-5, AC-10	275-350	350	350
AC-5 w/2% SBR, AC-10 w/2% SBR, AC-15P, AC-20-5TR	300-375	375	360
RC-250	125-180	200	200
RC-800	170-230	260	260
RC-3000	215-275	285	285
MC-30, AE-P	70-150	175	175
MC-250	125-210	240	240
MC-800, SCM I, SMC II	175-260	275	275
MC-3000, MC-2400L	225-275	290	290
HFRS-2, MS-2, CRS-2, CRS-2H, HFRS-2P, CRS-2P, CMS-2, CMS-2S, AES-300, AES-300S, AES-150P, AES-300P	120-160	180	180
SS-1, SS-1H, CSS-1, CSS-1H, PCE, EAP&T, SS-1P, RS-1P, CRS-1P, SCC-1P, recycling agent, emulsified recycling agent, polymer mod AE crack sealant	50-130	140	140
PG binders	275-305	350	350
Rubber asphalt crack sealers (Class A, Class B)	350-375	400	-
A-R binders Types, I, II, and III	325-425	425	425

300.5 MEASUREMENT AND PAYMENT.

The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly, but is subsidiary or is included in payment for other bid Items.

CITY OF SAN ANGELO

ITEM 301

ASPHALT ANTISTRIPPING AGENTS

301.1 DESCRIPTION.

This Item shall govern for furnishing and incorporating lime or liquid antistripping agents in the production of asphaltic concrete pavement mixtures and/or asphalt stabilized base mixtures.

301.2 MATERIALS.

(1) Lime. The Lime shall meet the requirements of Item 264, “Lime and Lime Slurry”.

(2) Liquid Antistripping Agent. The antistripping agent shall be a uniform liquid with no evidence of crystallization, settling or separation of components. Prior to delivery, a sample of the antistripping agent proposed for use shall be furnished to the City. Information to be provided with the sample includes the material safety data sheet, the specific gravity of the agent at the manufacturer's recommended addition temperature, the manufacturer's recommended dosage range and handling and storage instructions. The liquid antistripping agent shall be delivered in properly labeled containers, unopened as shipped from the manufacturer, or in sealed tank trucks properly invoiced.

301.3 MIXTURE DESIGN EVALUATION.

Laboratory mixtures of the proposed asphaltic pavement or base will be evaluated during mixture designing.

Hot-placed mixtures, except for Item 342, "Plant Mix Seal" surfacing mixture, will be evaluated for moisture susceptibility as follows, unless otherwise shown on the Plans. Test Method Tex-531-C will be the evaluation procedure, and a minimum tensile strength ratio of 0.70 is required. Laboratory mixture meeting this requirement will be tested in accordance with Test Method Tex-530-C to establish the maximum stripping to be allowed during production verification testing.

Cold-placed mixtures and Item 342, "Plant Mix Seal”, surfacing mixture will be evaluated as follows, unless otherwise shown on the Plans. Test Method Tex-530-C will be the evaluation procedure, and a maximum stripping of ten (10) percent is allowed.

If the proposed mixture does not comply with the specified resistance to moisture damage, the Contractor shall make changes in the combination of materials or add an antistripping agent in order to provide a mixture that will comply with the specified resistance to moisture damage.

When lime is used as an antistripping agent, the selected amount shall be in the range of 0.5 to 2.0 percent by weight of the individual aggregate being treated.

When a liquid antistripping agent is used, the selected amount of agent shall be from 0.3 to 1.0 percent by weight of the asphalt in the mixture but shall not exceed the amount recommended by the manufacturer.

When shown on the Plans, a limited number of addition rates will be evaluated for a given antistripping agent.

301.4 CONSTRUCTION METHODS.

(1) General. The Contractor shall provide all the necessary equipment for mixing, handling, metering and dispensing the asphalt antistripping agent.

The produced asphaltic mixture will be evaluated to verify resistance to moisture damage in accordance with Test Method Tex-530-C, unless otherwise shown on the Plans. When Test Method Tex-531-C is the required evaluation procedure during mixture design, the produced mixture shall not strip more than the percentage established during mixture design correlation testing with Test Method Tex-530-C. When Test Method Tex-530-C is the required evaluation procedure during mixture design, a maximum stripping of ten (10) percent is allowed in the produced mixture, unless otherwise shown on the Plans. If testing indicates that the required level of resistance to moisture damage is not being achieved in the plant mixture, production shall cease until trial production indicates that the problem has been corrected.

(2) Lime. Lime shall be added in slurry or dry form. It shall be added between the plant cold feeds and the dryer during mixture production, unless otherwise shown on the Plans. Whether added in slurry or dry form, the method of application shall be such that the lime is thoroughly mixed with the aggregates being treated.

The lime shall be applied to the aggregate at the required rate by means of a metering device. The Contractor shall demonstrate that the metering equipment will properly deliver the required rate of lime. The City must approve the metering equipment and location of lime application.

When lime is added in dry form, Type A hydrated lime shall be used. It shall be mixed with wet aggregate in a suitable pugmill mixer. Additional water shall be introduced into the mixer. If necessary to insure that the aggregate contains at least two (2) percent by weight moisture above the saturated surface dry condition.

(3) Liquid Antistripping Agent. Handling of liquid antistripping agent shall at all times be in accordance with the manufacturer's recommendations. The agent shall not show evidence of any separation or non-uniformity at time of use. For agents which have a high viscosity at normal ambient temperatures, the Contractor shall warm the material by suitable means to the application temperature recommended by the additive manufacturer so that proper consistency for accurate metering is assured. The agent shall be added to the asphalt line at the required rate by means of an in-line-metering device just prior to introduction of the asphalt into the mixing plant. The Contractor shall demonstrate that the meter meets the requirements of TxDOT Item 520, "Weighing and Measuring Equipment". A blending device is required to disperse the additive in the asphaltic material. The City must approve the metering and blending equipment and location.

301.5 MEASUREMENT AND PAYMENT.

The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the appropriate construction Item of the contract.

CITY OF SAN ANGELO

ITEM 302

AGGREGATES FOR SURFACE TREATMENTS

302.1 DESCRIPTION.

This Item shall govern for aggregates and precoated aggregates used in the construction of surface treatments.

302.2 MATERIALS.

(1) Aggregates. Aggregates shall be composed of gravel, crushed gravel, or crushed stone. When specified on the Plans, other aggregate types may be permitted or required. Aggregate from each source shall meet the requirements specified herein. Source is defined as a geographical location of naturally occurring material that can be mined or quarried from the original in-situ deposit.

The aggregate shall not contain more than two (2) percent by weight of soft particles and other deleterious material as determined by Test Method Tex-217-F, Part I.

The aggregate shall not contain more than one (1) percent loss from fine dust, clay-like particles and/ or silt when tested in accordance with Test Method Tex-217-F, Part II.

The flakiness index for the aggregate, as determined by Test Method Tex-224-F, shall not exceed 17 unless otherwise shown on the Plans.

The percent wear, as determined by Test Method Tex-410-A, for each of the materials shall not exceed 35 percent.

Crushed gravel shall have a minimum of 85 percent of the particles retained on the No. 4 sieve with two (2) or more mechanically induced crushed faces, as determined by Test Method Tex-460-A, Part I.

The aggregate will be subjected to five (5) cycles of magnesium sulfate soundness testing in accordance with Test Method Tex-411-A. The loss shall not exceed 25 percent, unless otherwise shown on the Plans.

The polish value for the aggregate used in the surface or finish course shall not be less than the value shown on the Plans, when tested in accordance with Test Method Tex-438-A. Unless otherwise shown on the Plans, the polish-value requirement will apply only to aggregate used on travel lanes. When aggregates requiring polish value are supplied from a source that is rated by the Materials and Tests Division, the Rated Source Polish Value (RSPV) for that source will be used to meet this requirement. When aggregates are supplied from a source that is not rated, the aggregate will be sampled and tested prior to use. The procedures will be in accordance with Test Methods Tex-400-A and Tex-438-A, Part I.

Blending of aggregates to achieve polish value will not be permitted, unless otherwise shown on the Plans. If blending is allowed, Test Method Tex-438-A, Part II, Method B will be used to determine the required blend percentages. However, a minimum of 50 percent by volume of non-polishing aggregate is required.

(2) Precoated Aggregate. Precoated aggregate shall be aggregate of the type and grade specified, coated with 0.5 to 1.5 percent, by weight, of residual bitumen from a precoating material.

When limestone rock asphalt is used, it shall be fluxed with 0.5 to 1.5 percent by weight of fluxing material.

The grade of aggregate specified shall meet all requirements of Articles 302.2 and 302.4 prior to the application of the precoat of fluxing material.

The materials may be mixed on the job or at a central mixing plant and shipped ready for use. Mixes that do not maintain flow qualities such that the precoated aggregate may be satisfactorily spread by approved mechanical spreading devices will not be acceptable.

Materials that are not uniformly and/or properly coated, in the opinion of the City, will not be accepted for use.

(3) Asphaltic Material. The precoating or fluxing material shall meet the requirements of Item 300 "Asphalts, Oils, and Emulsions". Unless otherwise shown on the Plans, any of the types and grades shown in Item 300, "Asphalt, Oils, and Emulsions" may be used.

(4) Water. Water in the amount not to exceed three (3) percent by weight of the mixture may be used in precoating aggregate or fluxing limestone rock asphalt aggregate.

302.3 TYPES.

Various aggregate types are identified as follows:

(1) Uncoated Aggregate Types.

Type A. Type A aggregate shall consist of gravel or crushed stone.

Type B. Type B aggregate shall consist of crushed gravel, or crushed stone.

Type C. Type C aggregate shall be as shown on the Plans.

Type D. Type D aggregate shall consist of crushed gravel, crushed slag or crushed stone.

Type E. Type E aggregate shall be as shown on the Plans.

(2) Precoated Aggregate Types.

Type PA. Type PA shall be precoated aggregate consisting of gravel or crushed stone.

Type PB. Type PB shall be precoated aggregate consisting of crushed gravel, or crushed stone.

Type PC. Type PE shall be precoated aggregate as shown on the Plans.

302.4 GRADES.

When tested by Test Method Tex-200-F, Part I, the gradation requirements shall be as follows:

		Percent By Weight
Grade 1:	Retained on 1" sieve	0
	Retained on 7/8" sieve	0 – 2
	Retained on 3/4" sieve	20 – 35
	Retained on 5/8" sieve	85 – 100
	Retained on 3/8" sieve	95 – 100
	Retained on No. 10 sieve	99 – 100
Grade 2:	Retained on 7/8" sieve	0
	Retained on 3/4" sieve	0 – 2
	Retained on 5/8" sieve	20 – 40
	Retained on 1/2" sieve	80 – 100
	Retained on 3/8" sieve	95 – 100
	Retained on No. 10 sieve	99 – 100
Grade 3:	Retained on 3/4" sieve	0
	Retained on 5/8" sieve	0 – 2
	Retained on 1/2" sieve	20 – 40
	Retained on 3/8" sieve	80 – 100
	Retained on 1/4" sieve	95 – 100
	Retained on No. 10 sieve	99 – 100
Grade 4:	Retained on 5/8" sieve	0
	Retained on 1/2" sieve	0 – 2
	Retained on 3/8" sieve	20 – 35
	Retained on No. 4 sieve	95 – 100
	Retained on No. 10 sieve	99 – 100
Grade 5:	Retained on 1/2" sieve	0
	Retained on 3/8" sieve	0 – 5
	Retained on No. 4 sieve	40 – 85
	Retained on No. 10 sieve	98 – 100
	Retained on No. 20 sieve	99 – 100

When shown on the Plans, the aggregate of the specified grade(s) shall have from 99.5 to 100 percent by weight retained on the No. 200 sieve.

302.5 EQUIPMENT.

(1) Mixing Plants. Mixing plants that will not continuously meet all the requirements of this specification shall be condemned.

Mixing plants may be either the weigh-batch type, the continuous mixing type or the drum mix type. All plants shall be equipped with satisfactory conveyors, power units, aggregate handling equipment, and bins.

If the City approves the use of emulsion as a precoat material, he may also waive the requirement for a dryer, as specified below, if it is demonstrated that a satisfactory coating can be obtained without drying or heating the aggregate.

When using a low-grade fuel oil or waste oil the plant shall meet the requirements of Item 340.4. (2).

(a) Weigh Batch Type.

Cold Aggregate Bin and Proportioning Device. The cold aggregate bins or aggregate stockpiles shall be of sufficient number and size to supply the amount of aggregate required to keep the plant in continuous operation. The proportioning device shall be such as will provide a uniform and continuous flow of aggregate in the desired proportion to the plant.

Dryer. The dryer shall continually agitate the aggregate during heating. The temperature shall be controlled so that the aggregate will not be damaged in the drying and heating operations.

The burner, or combination of burners, and type of fuel used shall be such that in the process of heating the aggregate to the desired or specified temperatures, no residue from the fuel shall adhere to the heated aggregate. A recording thermometer shall be provided which will record the temperature of the aggregate when it leaves the dryer. The dryer shall be of sufficient size to keep the plant in continuous operation. The dryer will not be required for precoating natural limestone rock asphalt.

Screening and Proportioning. The screening capacity and size of the bins shall be sufficient to screen and store the amount of aggregate required to properly operate the plant and keep the plant in continuous operation at full capacity. Proper provisions shall be made to enable inspection forces to have easy and safe access to the proper location on the mixing plant where accurate representative samples of aggregate may be taken from the bins for testing.

Weighing and Measuring Equipment. The weighing and measuring equipment shall be of sufficient capacity and of adequate design for proper batching. The following equipment, conforming to the requirements of TxDOT Item 520, “Weighing and Measuring Equipment”, shall be furnished:

1. Aggregate weigh box and batching scales.

2. Bucket and scales for precoat material or fluxing material.

A pressure type flow meter may be used to measure the precoat material or fluxing material for each batch.

If a pressure type flow meter is used to measure the asphaltic material, the requirements of TxDOT Item 520, "Weighing and Measuring Equipment" shall apply.

Provisions of a permanent nature shall be made for checking the accuracy of the asphaltic material-measuring device. The line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line near the temperature specified for the precoating material.

Mixer. The mixer shall be of the pugmill type, and shall have a capacity of not less than 3000 pounds in a single batch. Any mixer that has a tendency to segregate the aggregate or fails to secure a thorough and uniform mixing with the precoat material or fluxing material shall not be used. All mixers shall be provided with an automatic time lock that will lock the discharge doors of the mixer for the required mixing period. The dump door or doors and the shaft seals of the mixer shall be tight enough to prevent the spilling of aggregate or mixture from the pugmill.

(b) Modified Weigh-Batch Type.

General. This plant is similar to the weigh-batch type plant. The hot bin screens shall be removed and the aggregate control is placed at the cold feeds. The cold feed bins will be the same as those required for the drum-mix type plant.

Cold-Aggregate Bin Unit and Feed System. The number of bins in the cold-aggregate bin unit shall be equal to or greater than the number of stockpiles of individual materials to be used. The bins shall be of sufficient size to store the amount of aggregate required to keep the plant in continuous operation.

When blending materials, the bin unit shall be of proper design to prevent overflow of material from one bin to another. There shall be vertical partitions meeting the requirements of Item 340-4(2). The feed system shall provide a uniform and continuous flow of aggregate in the desired proportion to the dryer. The Contractor shall furnish a chart indicating the calibration of each cold bin in accordance with Construction Bulletin C-14, or other methods of cold bin calibration acceptable to the City.

Scalping Screen. A scalping screen shall be required after the cold feeds and ahead of the hot aggregate surge bins.

Dryer. The dryer shall continually agitate the aggregate during heating. The temperature shall be controlled so that the aggregate will not be damaged in the drying and heating operations. The dryer shall be of sufficient size to keep the plant in continuous operation.

Screening and proportioning. The hot aggregate shall not be separated into sizes after being dried. There shall be one or more surge bins provided between the dryer and the weigh

hopper. Surge bins shall be of sufficient size to hold enough combined aggregate for one complete batch of mixture.

Aggregate Weigh Box and Batching Scale. The aggregate weigh box and batching scales shall be of sufficient capacity to hold and weigh a complete batch of aggregate. The weigh box and scales shall conform to the requirements of TxDOT Item 520, "Weighing and Measuring Equipment".

Asphaltic Material Measuring System. If an asphaltic material bucket and scales are used, they shall be of sufficient capacity to hold and weigh the necessary asphaltic material for one batch. The bucket and scales shall conform to the requirements of TxDOT Item 520, "Weighing and Measuring Equipment".

If a pressure type flow meter is used to measure the asphaltic material, the requirements of TxDOT Item 520, "Weighing and Measuring Equipment", shall apply. This system shall include as automatic temperature compensation device to insure a constant percent by weight of asphaltic material in the mixture.

Provisions of a permanent nature shall be made for checking the accuracy of the asphaltic material-measuring device. The asphalt line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line near the temperature specified for the asphaltic material.

Mixer. The mixer shall be of the pugmill type and shall have a capacity of not less than 3,000 pounds (of natural-aggregate mixture) in a single batch, unless otherwise shown on the Plans. Any mixer that has a tendency to segregate the aggregate or fails to secure a thorough and uniform mixing with the precoat material or fluxing material shall not be used. All mixers shall be provided with an automatic timer that will lock the discharge doors of the mixer for the required mixing period. The dump door or doors and the shaft seals of the mixer shall be tight enough to prevent spilling of aggregate or mixture from the pugmill.

(c) Continuous Mixing Type.

Cold Aggregate Bin and Proportioning Device. Same as for weigh-batch type of plant.

Dryer. Same as for weigh-batch type of plant.

Screening and Proportioning. Same as for weigh-batch type of plant. These requirements shall also apply to materials that are stockpiled and that are proposed for direct use by a continuous mixing plant without the use of plant bins.

Aggregate Proportioning Device. The aggregate proportioning device shall be so designed that when properly operated a uniform and continuous flow of aggregate into the mixer will be maintained.

Spray Bar for Precoat Material and Fluxing Material. The spray bar for the precoat material or fluxing material shall be so designed that the material will spray uniformly and continuously into the mixer.

Meter for Precoat Material or Fluxing Material. An accurate recording meter for precoat material or fluxing material shall be placed in the line leading to the spray bar so that the accumulative amount of precoat material or fluxing material being used can be accurately determined. Provisions of a permanent nature shall be made for checking the accuracy of the meter output.

Mixer. The mixer shall be of the continuous type and shall have a capacity of not less than 40 tons of mixture per hour. Any mixer that has a tendency to segregate the aggregate or fails to secure a thorough and uniform mixing of the aggregate with the precoat material or fluxing material shall not be used.

(d) Drum Mix Plant

General. The plant shall be adequately designed and constructed for the process of mixing aggregates and precoat material. The plant shall be equipped with satisfactory conveyors, power units, aggregate-handling equipment and feed controls.

Cold Aggregate Bin and Feed System. The number of bins in the cold aggregate bin unit shall be equal to or greater than the number of stockpiles of individual materials to be used. The bin unit shall be of sufficient size to store the amount of aggregate required to keep the plant in continuous operation.

When blending materials, the bin unit shall be of proper design to prevent overflow of material from one bin to another. There shall be vertical partitions meeting the requirements of Item 340.4(2). The feed system shall provide a uniform and continuous flow of aggregate in the desired proportion to the dryer. The Contractor shall furnish a chart indicating the calibration of each cold bin in accordance with Construction Bulletin C-14 or other methods acceptable to the City.

The system shall provide positive weight measurement of the combined cold aggregate feed by use of belt scales. Provisions of a permanent nature shall be made for checking the accuracy of the measuring device as required by TxDOT Item 520, “Weighing and Measuring Equipment”. When a belt scale is used, mixture production shall be maintained so that the scale is used, mixture production shall be maintained so that the scale normally operates between 50 and 100 percent of its rated capacity. Belt scale operation below 50 percent of the rated capacity may be allowed by the City if accuracy checks show the scale to meet the requirements of TxDOT Item 520, “Weighing and Measuring Equipment”, at the selected rate and it can be satisfactorily demonstrated to the City that mixture uniformity and quality have not been adversely affected.

Scalping Screen. A scalping screen shall be required, after the cold feeds and ahead of the combined aggregate belt scale.

Precoat Material Measuring System. An asphaltic material measuring device meeting the requirements of TxDOT Item 520, “Weighing and Measuring Equipment”, shall be placed in the line leading to the mixer so that the cumulative amount of precoat material used can be accurately determined. Provisions of a permanent nature shall be made for checking the accuracy of the measuring device output. The line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line near the temperature specified for

the precoat material. The measuring system shall include an automatic temperature compensation device to maintain a constant percent by weight of precoating material in the mixture.

Synchronization Equipment for Feed-Control Systems. The precoat material feed-control shall be coupled with the total aggregate weight-measuring device to automatically vary the precoat material feed rate to maintain the required proportion.

Mix System. The mix system shall control the temperature so that aggregate and asphalt will not be damaged in the drying, heating and mixing operations. A continuously recording thermometer shall be provided which will indicate the temperature of the mixture as it leaves the mixer.

Surge-Storage System. A surge-storage system shall be required to minimize the production interruptions during the normal day's operations. A device such as a gob hopper or other similar devices approved by the City to prevent segregation in the surge-storage bin shall be required.

(2) Heating Equipment for Precoat Material and Fluxing Material. Heating equipment for precoat material and fluxing material shall be adequate to heat the required amount of material to the desired temperature. The material may be heated by steam coils, which shall be absolutely tight. Direct fire heating will be permitted, provided the heating system used is manufactured by a reputable concern and there is positive circulation of the liquid throughout the heater. Agitation with steam or air will not be permitted. The heating apparatus shall be equipped with a recording thermometer with a 24-hour chart that will record the temperature of the precoat material or fluxing material where it is at the point of highest temperature.

302.6 STORAGE, PROPORTIONS, AND MIXING.

(1) Aggregate Storage. If the aggregates are stored or stockpiled, they shall be handled in such a manner as to prevent segregation, the mixing of the various materials or sizes, and the contamination with foreign materials. The grading of aggregates proposed for use and as supplied to the mixing plant shall be uniform. When required by the City, additional material shall not be added to stockpiles that have been samples for approval.

When asphalt cement is the precoating material, stockpile height shall be limited to approximately three feet immediately after production to limit the build up of heat. These stockpiles may be consolidated after cooling adequately, in the opinion of the City.

The use of limestone rock asphalt aggregate containing moisture in excess of the saturated surface-dry condition will not be permitted. Excess moisture will be evidenced by the visual surface moisture on the aggregate or any unusual quantities of fines clinging to the aggregate.

(2) Storage and Heating of Precoating Material or Fluxing Material. The precoating or fluxing material storage shall be ample to meet the requirements of the plant. The precoating material shall not be heated in storage above the maximum temperature set forth in Item 300, “Asphalts, Oils, and Emulsions”. All equipment used in the storage and handling of precoat

material or fluxing material shall be kept in a clean condition at all times and shall be operated in such manner that there will be no contamination with foreign matter.

(3) Feeding and Drying of Aggregate. The feeding of various sizes of aggregate, other than natural limestone rock asphalt, to the dryer or drum mixer shall be done through the cold aggregate bin and proportioning device in such a manner that a uniform and constant flow of material in the required proportions will be maintained. The aggregate shall be heated to the temperature necessary to produce a mixture meeting the requirements of Item 302.2(3).

(4) Proportioning. The proportioning of the various materials entering into the mixture shall be as directed by the City and in accordance with these specifications. Aggregate shall be proportioned by weight using the weigh box and batching scales herein specified when the weigh-batch type of plant is used and by volume using the aggregate proportioning device when the modified weigh-batch type, the continuous mixer type or drum mix plant is used. The precoat material or fluxing material shall be proportioned by weight or by volume based on weight using the specified equipment.

(5) Mixing.

(a) Weigh-Batch Type and Modified Weigh-Batch Type Mixer. In the charging of the weigh box and in the charging of the mixer from the weigh box, such methods or devices shall be used as are necessary to secure a uniform mixture. In introducing the batch into the mixer, the aggregate shall be introduced first; shall be mixed thoroughly, as directed, to uniformly distribute the various sizes throughout the batch before the precoat material or fluxing material is added; the precoat material or fluxing material shall then be added and the mixing continued until such time that the aggregate is properly coated. This mixing period may be varied, if, in the opinion of the City, the mixture is not uniform.

(b) Continuous or Drum Mix Type Mixer. The amount of aggregate and precoat material or fluxing material entering the mixer and the rate of travel through the mixer shall be so coordinated that a uniform mixture of the specified grading and percent by weight of precoat material or fluxing material will be produced.

302.7 MEASUREMENT AND PAYMENT.

Aggregates provided in accordance with this specification will be measured and paid for in accordance with the governing specifications for the items of construction in which these materials are used.

CITY OF SAN ANGELO

ITEM 310

ASPHALT PRIME COAT

310.1 DESCRIPTION.

This Item shall consist of an application of asphaltic material on the completed base course in accordance with these specifications.

310.2 MATERIALS.

The asphaltic material used for the prime coat shall be of the type and grade shown on the plans and when tested by approved laboratory methods shall meet the requirements of Item 300, "Asphalts, Oils, and Emulsions".

310.3 CONSTRUCTION METHODS.

Prime coat shall not be applied when the air temperature is below 60ºF and falling, but it may be applied when the air temperature is above 50ºF and rising, the air temperature being taken in the shade away from artificial heat. Asphaltic material shall not be placed when general weather conditions, in the opinion of the City, are not suitable.

When, in the opinion of the City, the base is satisfactory to receive the prime coat, the surface shall be prepared by sweeping or other approved methods. If found necessary by the City, the surface shall be lightly sprinkled just prior to application of the asphaltic material. The asphaltic material shall be applied on the clean base by an approved type of self-propelled pressure distributor so operated as to distribute the material at the rate directed by the City, evenly and smoothly, under a pressure necessary for proper distribution. 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 (2) distributor loads.

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 and shall be operated in such manner that there will be no contamination of the asphaltic material with 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 tank, when used for pay purposes, shall have been calibrated within ten years from the date it is first used on this project, unless modifications and or changes occur in the tank system that may alter the volume. The tank calibration procedure shall be in accordance with Test Method Tex-922-K, Part I, and shall be signed and sealed by a registered professional engineer. Unless otherwise shown on the plans, the Contractor shall provide the tank calibration and shall furnish the City an accurate and satisfactory calibration record prior to beginning the work.

The City may at any time verify calibration accuracy in accordance with Test Method Tex-922-K, Part II, and may perform the required recalibration if the calibration is found to be in error.

The City will select the temperature of application and the Contractor shall apply the asphalt at a temperature within 15ºF of the temperature selected.

WARNING TO CONTRACTORS. Attention is called to the fact that asphaltic materials are flammable. The utmost care should be taken to prevent open flames from coming in contact with the asphaltic material or the gases of it. The Contractor shall be responsible for any fires or accidents, which may result from heating the asphaltic materials.

The Contractor shall be responsible for the maintenance of the surface until the work is accepted by the City.

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

The asphalt or emulsion may be diluted as directed by the City, but in no case shall the base asphalt material may be diluted no more than 30 percent. Pay for prime will be by the gallon of asphalt actually used before dilution.

310.4 MEASUREMENT.

This Item will be measured at the point of delivery on the road by the gallon of asphaltic material at the applied temperature. The quantity to be measured for payment shall be the number of gallons used, as directed, of the accepted prime coat.

310.5 PAYMENT.

The work performed and materials furnished in accordance with this Item and measured as provided under Item 310.4, “Measurement” will be paid for at the unit price bid for “Asphaltic Material”, of the type and grade specified. This price shall be full compensation for cleaning the area to be primed; for furnishing all required materials; for all heating, hauling, mixing and distributing the asphaltic material as specified; for all freight involved; and for all manipulation, labor, tools, equipment and incidentals necessary to complete the work.

CITY OF SAN ANGELO

ITEM 316

SURFACE TREATMENT

316.1 DESCRIPTION.

This Item shall govern for the construction of a surface treatment composed of a single, double or triple application of asphaltic material, each covered with aggregate, constructed on existing pavements or on the prepared base course or surface in accordance with these specifications. Quantities for the different types of surfaces and materials will be shown on the Basis of Estimate in the Plans.

316.2 MATERIALS.

All materials shall be of the type and grade shown on the Plans and shall conform to the pertinent material requirements of the following Items:

Item 300, "Asphalts, Oils, and Emulsions"

Item 302, "Aggregate for Surface Treatments"

TxDOT Item 303, "Aggregate for Surface Treatments (Lightweight)"

316.3 EQUIPMENT.

(1) Distributor. The distributor shall be a self-propelled pressure type, equipped with an asphaltic material heater and a distributing pump capable of pumping the material at the specified rate through the distributor spray bar. The distributor spray bar shall be capable of fully circulating the asphaltic material. In order to prevent streaking or irregular distribution of asphaltic material, the distributor spray bar shall contain nipples and valves so constructed that the nipples will not become partially plugged with congealing asphaltic material. Distributor equipment shall include a tachometer, pressure gauges, volume measuring devices, and a thermometer for reading the temperature of tank contents.

The distributor tank when used for pay purposes, shall have been calibrated within three (3) years from the date it is first used on this project. The tank calibration procedure shall be in accordance with Test Method Tex-922-K, Part 1, and shall be signed and sealed by a registered professional engineer. Unless otherwise shown on the Plans, the Contractor shall provide the tank calibration record prior to beginning the work. The City may at any time verify calibration accuracy in accordance with Test Method Tex-922-K, Part II, and may perform the required re-calibration if the calibration is found to be in error.

When a uniform application of asphaltic material is not being achieved, the City may require that the spray bars on the distributor be controlled by an operator riding in such a position at the rear of the distributor that operation of all sprays is in full view.

(2) Aggregate Spreader. A self-propelled continuous-feed aggregate spreader shall be used which will uniformly spread aggregate at the rate specified by the City.

(3) Rollers. Rolling equipment shall meet the governing specifications for Item 210, "Rolling (Flat Wheel)" and Item 213, "Rolling (Pneumatic Tire)".

(4) Broom. The broom shall be a rotary, self-propelled power broom for cleaning existing surfaces.

(5) Asphalt Storing and Handling Equipment. All equipment used in storing or handling asphaltic material shall be kept clean and in good operating condition at all times and shall be operated in such a manner that there will be no contamination of the asphaltic material. The Contractor shall provide and maintain a recording thermometer to continuously indicate the temperature of the asphaltic material at the storage heating unit when storing of asphalt is permitted.

(6) Vehicles used for hauling aggregate shall be of uniform capacity unless otherwise authorized by the City.

316.4 CONSTRUCTION METHODS.

(1) General. Temporary stockpiling of aggregates on the right-of-way will be permitted, provided that the stockpiles are so placed as to allow for the safety of the traveling public and not obstruct traffic or sight distance, and do not interfere with access from abutting property, nor with roadway drainage.

The aggregate placement sites will be subject to the City. Location of stockpiles shall be either a minimum of 30 feet from the edge of the travel lanes or shall be signed and barricaded as shown on the Plans.

Surface treatments shall not be applied when the air temperature is below 60º F. and is falling, but may be applied when the air temperature is above 50º F. and is rising, the air temperature being taken in the shade and away from artificial heat. Surface treatments shall not be applied when the temperature of the surface on which the surface treatment is to be applied is below

60º F. When latex modified asphalt cement is specified, surface treatments shall not be applied when the air temperature is below 80º F. and is falling, but may be applied when air temperature is above 70 F. and is rising and shall not be applied when the temperature of the surface on which the surface treatment is to be applied is below 70º F. When cutback asphalt or asphaltic materials designed for cool weather placement are used, application may occur whenever the air and surface temperatures are acceptable to the City. Asphaltic material shall not be placed when general weather conditions, in the opinion of the City, are not suitable.

The area to be treated shall be cleaned of dirt, dust or other deleterious matter by sweeping or other approved methods. If it is found necessary by the City, the surface shall be lightly sprinkled with water just prior to the application of asphaltic material. The rates shown on the Plans for asphalt and aggregate are for estimating purposes only. The rates may be varied as directed by the City.

The City will select the temperature of application within the limits recommended in Item 300, "Asphalts, Oils and Emulsions". The Contractor shall apply the asphalt at a temperature within 15° F. of the temperature selected.

The width of each application of asphaltic material shall be such to allow uniform application and immediate covering with aggregate. The Contractor shall be responsible for uniform application of asphaltic material at the junction of distributor loads. Paper or other suitable material shall be used to prevent overlapping of transverse joints. Longitudinal joints shall match lane lines unless otherwise authorized by the City. Application of asphaltic material will be measured as necessary to determine the rate of application.

The Contractor shall clear the finished surface of any surplus aggregate by sweeping or other approved methods after all rolling is completed.

Prior to final acceptance of the project, aggregate stockpiles deemed undesirable by the City shall be removed by the Contractor. The temporary stockpile areas shall be left in a neat condition satisfactory to the City.

When plans include "Aggregate (Stockpiled)", aggregate of the type and grade specified shall be stockpiled within the limits of the project at sites designated by the City.

(2) One-Course Surface Treatments or First Course of a Multiple Surface Treatment. Asphaltic material shall be applied by an approved distributor so operated as to distribute the material under a pressure necessary for uniform distribution.

The Contractor shall protect the existing raised pavement markers by any means acceptable to the City for one-course surface treatments, unless otherwise shown on the Plans.

Aggregates shall be immediately and uniformly applied and spread by the specified aggregate spreader, unless otherwise authorized by the City.

After applying the aggregate, the entire surface shall then be broomed, bladed or raked as required by the City and shall be thoroughly rolled with the type or types of rollers specified herein or as shown on the Plans.

The Contractor shall be responsible for the maintenance of the surface treatment until the City accepts the work. All holes or failures in the surface shall be repaired by use of additional asphalt and aggregate. All fat or bleeding surfaces shall be covered with approved cover material in such a manner that the asphaltic material will not adhere to or be picked up by the wheels of vehicles.

(3) Two Course or Three Course Surface Treatments. It is the intent of this specification that the application of asphalt and aggregate for multiple courses be applied within the same day or immediately thereafter and prior to opening the roadway to traffic.

The asphaltic material for each course of the surface treatment shall be applied and covered with aggregate in the same manner specified for the first application. Each surface shall then be broomed,

bladed or raked as required by the City and thoroughly rolled as specified for the first course. Asphaltic material and aggregate for each course shall be applied at the rates directed by the City.

The Contractor shall be responsible for the maintenance of each course until covered by the succeeding course or until the work is accepted by the City. All holes or failures in the surface shall be repaired by use of additional asphalt and aggregate. All fat or bleeding surface shall be covered with approved cover material in such a manner that the asphaltic material will not adhere to or be picked up by the wheels of vehicles.

316.5 MEASUREMENT.

(1) Asphalt Material. Asphaltic material will be measured as follows and as specified on the Plans.

(a) Volume. Asphaltic material will be measured at point of application on the road in gallons at the applied temperature. The quantity to be measured for payment shall be the number of gallons used, as directed, in the accepted surface treatment.

(2) Aggregates. Aggregate will be measured by the cubic yard in vehicles as applied on the road.

316.6 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 prices bid for "Asphalt" and "Aggregate", of the type and grade specified. These prices shall each be full compensation for cleaning and sprinkling the existing surface; for furnishing, preparing, hauling, and placing all materials; for protecting existing pavement markers; for rolling, removing excess aggregate, and cleaning up stockpiles; for all freight and heating involved; and for all manipulations, labor, tools, equipment, and incidentals necessary to complete the work.

CITY OF SAN ANGELO

ITEM 340

HOT MIX ASPHALTIC CONCRETE PAVEMENT

340.1. DESCRIPTION.

This Item shall govern for the construction of a base course, a level-up course, a surface course or any combination of these courses as shown on the Plans, each course being composed of a compacted mixture of aggregate and asphalt cement mixed hot in a mixing plant, in accordance with the details shown on the Plans and the requirements herein.

340.2. MATERIALS.

The Contractor shall furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications. Contractor shall notify the Engineer of all material sources. Contractor shall notify the Engineer before changing any material source or formulation. When the Contractor makes a source or formulation change, the Engineer will verify that the requirements of this Item are met and may require a new laboratory mixture design, trial batch, or both. The Engineer may sample and test project materials at any time during the project to verify compliance.

(1) Aggregate. The aggregate shall be composed of a coarse aggregate, a fine aggregate, and if required or allowed, mineral filler and may include reclaimed asphalt pavement (RAP). The use of RAP may be required on the Plans. RAP use will be allowed in all mixtures except as specifically excluded herein or on the Plans. Samples of each aggregate shall be submitted for approval in accordance with TxDOT Item 6, "Control of Materials".
Aggregate from each stockpile shall meet the quality requirements of Table 1 and other requirements as specified herein. The aggregate contained in RAP will not be required to meet Table 1 requirements except as shown on the Plans.

(a) Coarse Aggregate. Coarse aggregate stockpiles must have no more than 20% material passing the No. 8 sieve. Contractor is to provide aggregates from sources listed in the *Bituminous Rated Source Quality Catalog* (BRSQC). Contractor is to provide aggregate from nonlisted sources only when tested by the Engineer and approved before use. Allow 30 calendar days for the Engineer to sample, test, and report results for nonlisted sources. Contractor is to provide coarse aggregate with at least the minimum surface aggregate classification (SAC) shown on the plans. SAC requirements apply only to aggregates used on the surface of travel lanes, unless otherwise shown on the plans.

Class B aggregate meeting all other requirements in Table 1 may be blended with a Class A aggregate in order to meet requirements for Class A materials. When blending Class A and B aggregates to meet a Class A requirement, ensure that at least 50% by weight of the material retained on the No. 4 sieve comes from the Class A aggregate source. Blend by volume if the bulk specific gravities of the Class A and B aggregates differ by more than 0.300. When

blending, do not use Class C or D aggregates. For blending purposes, coarse aggregate from RAP will be considered as Class B aggregate.

(b) Reclaimed Asphalt Pavement (RAP). RAP is defined as a salvaged, milled, pulverized, broken or crushed asphaltic pavement. The RAP to be used in the mix shall be crushed or broken to the extent that 100 percent will pass the (two) 2-inch sieve.

Dirt or other objectionable materials shall not contaminate the stockpiled RAP. Unless otherwise shown on the Plans, stockpiled, crushed RAP must have either a decantation of no more than 5 percent or a plasticity index of no more than eight (8), when tested in accordance with Test Method Tex-406-A, Part I, or Test Method Tex-106-E / ASTM D 4318, respectively. This requirement applies to stockpiled RAP from which the asphalt has not been removed by extraction.

City-owned RAP sources that are designated on the Plans will be available for use by the Contractor. Only RAP from City-owned sources will be allowed in mixes using more than 20 percent RAP, unless otherwise shown on the Plans. When RAP sources are designated, either in stockpile or existing pavements, the approximate gradation, asphalt content, and asphalt cement properties of this material will be shown on the Plans for material existing in pavements, or in a special provision "Local Material Sources for Reclaimed Asphaltic Pavement" for material in existing stockpiles. Any Contractor-owned RAP that is to be used on this project shall remain the property of the Contractor while stockpiled and shall not be intermingled with City-owned RAP stockpiles. Any unused Contractor-owned RAP material shall be removed from the project site upon completion of the project.

Only RAP from designated sources may be used in surface courses.

Excess RAP removed from designated sources will remain the property of the City and will be delivered to stockpile locations shown on the Plans.

(c) Fine Aggregate. Fine aggregates consist of manufactured sands, screenings, and field sands. The fine aggregate is defined as that part of the aggregate passing the No. 10 sieve and shall be of uniform quality throughout. When specified on the Plans, certain fine aggregate material may be allowed, required or prohibited. However, a maximum of 15 percent of the total virgin aggregate may be field sand or other uncrushed fine aggregate.

Fine aggregate stockpiles must meet the gradation requirements in Table 2. Supply fine aggregates that are free from organic impurities. The Engineer may test the fine aggregate in accordance with Tex-408-A to verify the material is free from organic impurities. At most 15% of the total aggregate may be field sand or other uncrushed fine aggregate. With the exception of field sand, use fine aggregate from coarse aggregate sources that meet the requirements shown in Table 1, unless otherwise approved. If 10% or more of the stockpile is retained on the No. 4 sieve, test the stockpile and verify that it meets the requirements in Table 1 for coarse aggregate angularity (Tex-460-A) and flat and elongated particles (Tex-280-F).

TABLE 1
AGGREGATE QUALITY REQUIREMENTS*

Property	Test Method	Requirement
COARSE AGGREGATE		
SAC	AQMP	As shown on plans
Deleterious Material, % max	Tex-217-F Part I	1.5
Decantation, %, max	Tex-217-F Part II	1.5
Micro-Deval abrasion, %, max	Tex-461-A	Note 1
Los Angeles abrasion, %, max	Tex-410-A	40
Magnesium sulfate soundness, 5 cycles, %, max	Tex-411-A	30[2]
Coarse aggregate angularity, 2 crushed faces, %, min	Tex-460-A, Part I	85[3]
Flat and elongated particles@ 5:1, %, max	Tex-280-F	10
FINE AGGREGATE		
Linear Shrinkage, %, max	Tex-107-E	3
COMBINED AGGREGATE[4]		
Sand Equivalent, %, min	Tex-203-F	45

1. Not used for acceptance purposes. Used by the Engineer as an indicator of the need for further investigation.
2. Unless otherwise shown on the plans.
3. Unless otherwise shown on the plans. Only applies to crushed gravel.
4. Aggregates, without mineral filler, RAP, or additives, combined as used in the job-mix formula (JMF).

TABLE 2
GRADATION REQUIREMENTS FOR FINE AGGREGATE

Sieve Size	% Passing by Weight or Volume
3 / 8”	100
#8	70 - 100
#200	0 - 3

Screenings shall be supplied from sources whose coarse aggregate meets the Los Angeles abrasion and magnesium sulfate soundness loss requirements shown in Table 1, unless otherwise shown on the Plans.

(d) Mineral Filler. Mineral filler shall consist of thoroughly dried stone dust, Portland cement, lime, fly ash, or other mineral dust approved by the City. The mineral filler shall be free from foreign matter.

When a specific type of mineral filler is specified on the Plans, fines collected by the baghouse or other air cleaning or dust collecting equipment shall not be used to meet this requirement. When mineral filler is not specifically required, the addition of baghouse or other collected fines will be permitted if the mixture quality is not adversely affected in the opinion of the City. In no

case shall the amount of material passing the No. 200 sieve exceed the tolerances of the job-mix formula or the master gradation limits.

When mineral filler is specified or allowed by the City, or baghouse fines are permitted to be added to the mixture, it shall be proportioned into the mix by a vane meter or an equivalent measuring device acceptable to the City. A hopper or other acceptable storage system shall be required to maintain a constant supply of mineral filler to the measuring device.

The measuring device for adding mineral filler shall be tied into the automatic plant controls so that the supply of mineral filler will be automatically adjusted to plant production and provide a consistent percentage to the mixture. When shown on the Plans, the measuring device for adding baghouse fines shall have controls in the plant control room, which will allow manual adjustment of feed rates to match plant production rate adjustments.

When mineral filler is used, it may not exceed 3% linear shrinkage when tested in accordance with Tex-107-E. When tested by Test Method Tex-200-F (Part I or Part III, as applicable), the mineral filler shall meet the gradation requirements of Table 3, unless otherwise shown on the Plans.

TABLE 3
GRADATION REQUIREMENTS FOR MINERAL FILLER

Sieve Size	% Passing by Weight or Volume
#8	100
#200	55 - 100

(2) Asphaltic Material.

(a) Paving Mixture. Asphalt cement for the paving mixture shall be of the grade shown on the Plans or designated by the City and shall meet the requirements of the Item 300, "Asphalts, Oils and Emulsions". The Contractor shall notify the City of the source of the asphaltic material prior to design of the asphaltic mixture. This source shall not be changed during the course of the project without authorization of the City. Should the source of asphaltic material be changed, the moisture resistance of the new material combination will be evaluated to verify that the requirements of Section 340.3(1) are met.

(b) RAP Paving Mixture. When more than 20 percent RAP is used in the produce mixture, the asphalt in the RAP shall be restored to the properties indicated below. Restoration will be made by adding asphalt recycling agent and/or virgin asphalt cement meeting the requirements of Item 300, "Asphalts, Oils, and Emulsions".

The mixture design will include recovery of asphalt from the RAP in accordance with Test Method Tex-211-F. The recovered asphalt shall be blended in the laboratory with the amount of asphalt cement and/or asphalt recycling agent selected for the project. The following tests shall be performed on the laboratory blend:

i. Viscosity, 140° F, poises - Test Method Tex-528-C

ii. Thin Film Oven Aging Test - Test Method Tex-510-C

iii. Viscosity, 140° F, poises, on residue from the Thin Film Oven Aging Test - Test Method Tex-528-C

iv. Penetration at 77° F, 100 g, 5 sec, on residue from the Thin Film Oven Aging Test - Test Method Tex-502-C

The viscosity in poises equivalent to the residue penetration at 77° F shall be calculated as set forth in Test Method Tex-535-C. The viscosity index of the residue shall then be calculated as follows:

$$\text{Residue Viscosity Index} = \frac{\text{Residue Viscosity, poises, equivalent to Penetration at } 77^{o}\text{F}}{\text{Residue Viscosity, } 140^{o}\text{F, poises}}$$

The aging index of the laboratory blended asphalt shall be determined as follows:

$$\text{Aging Index} = \frac{\text{Residue Viscosity, } 140^{o}\text{F, poises}}{\text{Original Viscosity, } 140^{o}\text{F, poises}}$$

The laboratory blended asphalt shall meet the following requirements:

Residue Viscosity Index, maximum 1500
Aging Index, maximum.....3.0

Samples of asphalt recovered from plant produced mixture shall show the asphalt to meet the following requirements when tested in accordance with Test Methods Tex-211-F and Tex-502C:

	Minimum	**Maximum**
Penetration, 77°F, 100 g, 5 sec	30	55

(c) Tack Coat. Asphaltic materials, shown on the Plans or approved by the City, shall meet the requirements of Item, 300, "Asphalts, Oils and Emulsions".

(3) Additives. Additives to facilitate mixing and/or improve the quality of the asphaltic mixture or tack coat shall be used when noted on the Plans or may be used with the authorization of the City.

Unless otherwise shown on the Plans, the Contractor may choose to use either lime or a liquid antistripping agent to reduce the moisture susceptibility of the aggregate. The evaluation and addition of antistripping agents will be in accordance with Item 301, "Asphalt Antistripping Agents".

340.3. PAVING MIXTURES.

The paving mixtures shall consist of a uniform mixture of aggregate, hot asphalt cement, and additives if allowed or required.

An asphalt mixture design is a laboratory process, which includes the determination of the quality of the asphalt and the individual aggregates, the development of the job-mix formula, and the testing of the combined mixture.

The job-mix formula lists the quantity of each component to be used in the mix and the combined gradation of the aggregates used.

(1) Mixture Design. The Contractor shall furnish the City with representative samples of the materials to be used in production. Using these materials, the mix shall be designed in accordance with Construction Bulletin C-14 and Test Method Tex-204-F to conform with the requirements herein. Unless otherwise shown on the Plans, the City will furnish the mix design for the mixtures when using 20 percent or less RAP. The City may accept a design from the Contractor, which was derived using these design procedures.

The second and subsequent mixture designs, or partial designs, for each type of paving mixture which are necessitated by changes in the material or at the request of the Contractor will be charged to the Contractor when a rate is shown on the Plans.

The Contractor shall furnish the mixture design for all mixtures containing more than 20 percent RAP. This mixture design shall include, in addition to the results of the tests required for virgin mixes, the results of tests run on the proposed asphalt blend. The Contractor shall furnish the City with representative samples of all materials to be used in the proposed mixture. The City will verify the proposed mixture design. Should the City's tests find that the proposed mixture design does not meet the requirements of this specification, the Contractor shall furnish another mixture design.

The bulk specific gravity will be determined for each aggregate to be used in the design mixture. If the determined values vary by 0.30 or more, the Volumetric Method, Test Method Tex-204-F, Part II, will be used. The Bulk specific gravity of aggregates in RAP will be determined on extracted aggregates. Provide the Engineer with split samples of the mixtures and blank samples used to determine the ignition oven correction factors. The Engineer will determine the aggregate and asphalt correction factors from the ignition oven using Tex-236-F. The Engineer will use a Texas gyratory compactor calibrated in accordance with Tex-914-F in molding production samples. The Engineer will perform Tex-530-C and retain the tested sample for comparison purposes during production. The Engineer may waive the requirement for the boil test.

When properly proportioned, for the type specified, the blend of aggregates shall produce an aggregate gradation, which will conform to the limits of the master grading shown in Table 4. Unless otherwise shown on the Plans, the gradation of the aggregate will be determined in accordance with Test Method Tex-200-F, Part I (Dry Sieve Analysis), to develop the job-mix formula.

The master grading limits for the appropriate type and the proposed job-mix formula will be plotted on a gradation chart with sieve sizes raised to the 0.45 power. This plot must show that the promised job-mix formula is within the limits of the master grading. Gaps in gradation shown by this plot should be avoided.

TABLE 4

MASTER GRADING BANDS (% PASSING BY WEIGHT OR VOLUME) AND VOLUMETRIC PROPERTIES

Sieve Size	Type				
	A Coarse Base	**B Fine Base**	**C Coarse Surface**	**D Fine Surface**	**F Fine Mixture**
1-1/2”	98 - 100	--	--	--	--
1”	78 - 94	98 - 100	--	--	--
3/4”	64 - 85	84 - 98	95 - 100	--	--
1/2”	50-70	--	--	98 - 100	--
3/8”	--	60 - 80	70 - 85	85 - 100	98 - 100
#4	30 - 50	40 - 60	43 - 63	50 - 70	80 -86
#8	22 - 36	29 - 43	32 - 44	35 - 46	38 - 48
#30	8 - 23	13 - 28	14 - 28	15 - 29	12 - 27
#50	3 - 19	6 - 20	7 - 21	7 - 20	6 – 19
#200	2 - 7	2 - 7	2 - 7	2 - 7	2 - 7
Design VMA[1], % Minimum					
--	12	13	14	15	16
Plant-Produced VMA, % Minimum					
--	11	12	13	14	15

1. Voids in Mineral Aggregates.

The voids in the mineral aggregate (VMA) will be determined as a mixture design requirement only, in accordance with Test Method Tex-207-F, and shall not be less than the value indicated in Table 4.

Unless otherwise shown on the Plans, the mixture of aggregate, asphalt and additives proposed for use will be evaluated in the design stage for moisture susceptibility, in accordance with Item 301, “Asphalt Antistripping Agents”. The City may waive this test if a similar design, using the same ingredients, has proven satisfactory.

To substantiate the design, trial mixtures shall be produced and tested using all of the proposed project materials and equipment prior to any placement. The City may waive trial mixtures if similar designs have proven satisfactory.

(2) Density. The mixture should be designed to produce an acceptable mixture at optimum density of 96 percent, when tested in accordance with Test Method Tex-207-F and Test Method Tex-227-F. The operating range for control of laboratory density during production shall be optimum density plus or minus 1.5 percent.

Laboratory density is a mixture design and process control parameter. If the laboratory density of the mixture produced has a value outside the range specified above, the Contractor shall investigate the cause and take corrective action. If three consecutive test results fall outside the specified range, production shall cease unless test results or other information indicate, to the satisfaction of the City, that the next mixture to be produced will be within the specified range.

(3) Stability. The materials used in the mixture design shall produce a mixture with a stability value of at least 35, unless otherwise shown on the Plans, when tested in accordance with Test Method Tex-208-F.

If, during production, the stability value falls below the specified minimum, the City and the Contractor shall closely evaluate other test result values for specification compliance such as gradation, asphalt content, moisture content, crushed faces, etc., to determine the cause and take corrective action. If three consecutive test results fall below the minimum value specified, production shall cease unless test results or other information indicate, to the satisfaction of the City, that the next material to be produced will meet the minimum value specified.

(4) Job-Mix Formula Field Adjustments. The Contractor shall produce a mixture of a uniform composition closely conforming to the approved job-mix formula.

If, during initial days of production, it is determined that adjustments to the mixture design job-mix formula are necessary to achieve the specified requirements, or to more nearly match the aggregate production, the City may allow adjustment of the mixture design job-mix formula within the tolerances of Table 5 without a laboratory redesign of the mixture.

The Engineer will adjust the asphalt content to maintain desirable laboratory density near the optimum value while achieving other mix requirements.

(5) Types. The aggregate gradation of the job-mix formula shall conform to the master grading limits shown in Table 4 for the type mix specified on the Plans.

(6) Operational Tolerances. The gradation of the aggregate and the asphalt cement content of the produced mixture shall not vary from the job-mix formula by more than the tolerances shown in Table 5.

During production, the Contractor shall not exceed the operational tolerances in Table 5. Stop production if testing indicates tolerances are exceeded on:

- 3 consecutive tests on any individual sieve,
- 4 consecutive tests on any of the sieves, or
- 2 consecutive tests on asphalt content.

Begin production only when test results or other information indicate, to the satisfaction of the Engineer, that the next mixture produced will be within Table 5 tolerances.

TABLE 5
OPERATIONAL TOLERANCES

Description	Test Method	Allowable Difference from JMF Target
Individual % retained for #8 sieve and larger	Tex-200-F or Tex-236-F	±5.0[1]
Individual % retained for sieves smaller than #8 and larger than #200		±3.0[1]
% passing the #200 sieve		±2.0[1]
Asphalt content, %	Tex-236-F	±0.3[1]
Laboratory-molded density, %	Tex-207-F	±1.0
VMA, %, min		Note 2

1. When within these tolerances, mixture production gradations may fall outside the master grading limits; however, the percent passing the #200 sieve will be considered out of tolerance when outside the master grading limits.
2. Test and verify that Table 4 requirements are met.

When disagreements concerning determination of specification compliance occur between allowed sampling and testing procedures, extracted aggregate testing shall take precedence over cold feed belt testing.

When cold feed belt samples are used for job control, the City will select the sieve analysis method that corresponds with the one used to determine the mixture design gradation. The tolerances will be adjusted as outlined in Test Method Tex-229-F.

340.4. EQUIPMENT .

(1) General. All equipment for the handling of all materials, mixing, placing and compacting of the mixture shall be maintained in good repair and operating condition and subject to the approval of the City. Any equipment found to be defective and potentially having a negative effect on the quality of the paving mixture or ride quality will not be allowed.

(2) Mixing Plants. Mixing plants may be the weigh-batch type, the modified weigh-batch type, the drum-mix type, or the specialized recycling type. All plants shall be equipped with satisfactory conveyors, power units, mixing equipment, aggregate handling equipment, bins and dust collectors.

Automatic proportioning devices are required for all plants and shall be in accordance with TxDOT Item 520, “Weighing and Measuring Equipment”.

It shall be the Contractor's responsibility to provide safe and accurate means to enable inspection forces to take all required samples, to provide permanent means for checking the output of any specified metering device, and to perform calibration and weight checks as required by the City. When cold feed belt sampling is to be used for gradation testing, occasional stoppage of the belt may be necessary unless the City approves other means of sampling.

When using fuel oil heavier than Grade No. 2, or waste oil, the Contractor shall insure that the fuel delivered to the burner is at a viscosity of 100 SSU or less, when tested in accordance with Test Method Tex-534-C, to insure complete burning of the fuel. Higher viscosities will be allowed if recommended by the burner manufacturer. If necessary, the Contractor shall preheat the oil to maintain the required viscosity.

The Contractor shall provide means for obtaining a sample of the fuel, just prior to entry into the burner, in order to perform the viscosity test. The Contractor shall perform this test or provide a laboratory test report that will establish the temperature of the fuel necessary to meet the viscosity requirements. There shall be an in-line thermometer to check the temperature of the fuel delivered to the burner.

Regardless of the burner fuel used, the burner or combination of burners and types of fuel used shall provide a complete burn of the fuel and not leave any fuel residue that will adhere to the heated aggregate or become mixed with the asphalt.

(a) Weigh-Batch Type.

Cold Aggregate Bin Unit and Proportioning Device. The cold aggregate bin unit shall have at least four bins of sufficient size to store the amount of aggregate required to keep the plant in continuous operation and of proper design to prevent overflow of material from one bin to another. There shall be vertical partitions between each bin and on each end of the bins of sufficient height so that any overflow will be on to the front and back, and not allow overflow to the sides or between bins. Overflow that might occur shall not fall onto any feeder belt. The proportioning device shall not fall onto any feeder belt. The proportioning device shall provide a uniform and continuous flow of aggregate in the desired proportion to the dryer. Each aggregate shall be proportioned from a separate bin.

If RAP is used, a separate cold bin shall be required. The RAP feed system shall be equipped with a scalping screen to remove particles over two (2) inches in size. The cold bin system shall supply the proper amount of RAP to the weigh box. RAP will not be allowed in the hot bins.

When mineral filler is used, as specified in Section 340.2 (1)(d), an additional bin shall be provided.

Dryer. The dryer shall continually agitate the aggregate during heating. The temperature shall be controlled so that the aggregate will not be damaged in the drying and heating operations. The dryer shall be of sufficient size to keep the plant in continuous operation.

Screening and Proportioning. The screening capacity and size of the hot aggregate bins shall be sufficient to screen and store the amount of aggregate required to properly operate

the plant and keep the plant in continuous operation at full capacity. The hot bins shall be constructed so that oversize and overloaded material will be discarded through overflow chutes.

Provisions shall be made to enable inspection forces to have easy and safe access to the proper location on the mixing plant where representative samples may be taken from the hot bins for testing. The aggregate shall be separated into at least four (4) bins when producing Type "A", Type "B" or Type "C" mixtures, at least three (3) bins when producing Type "D"" mixture and at least two bins when producing Type "F" mixture. These bins shall contain the following sizes of aggregates in percentages by weight or by volume, as applicable.

Type "A" (Coarse Graded Base Course):

Bin No. 1 - shall contain aggregates of which 85 to 100 percent will pass the No. 10 sieve.

Bin No. 2 - shall contain aggregates of which at least 85 percent will be of such size as to pass the 1/2 inch sieve and be retained on the No. 10 sieve.

Bin No. 3 - shall contain aggregates for which at least 85 percent will be of such size as to pass the 7/8 inch sieve and be retained on the 3/8 inch sieve.

Bin No. 4 - shall contain aggregates of which at least 85 percent will be of such size as to pass the 1-1/2 inch sieve and be retained on 7/8 inch sieve.

Type "B" (Fine-Graded Base):

Bin No. 1 - shall contain aggregates of which 85 to 100 percent will pass the No. 10 sieve.

Bin No. 2 - shall contain aggregates of which at least 70 percent will be of such size as to pass the No. 4 sieve and be retained on the No. 10 sieve.

Bin No. 3 - shall contain aggregates for which at least 75 percent will be of such size as to pass the 3/8 inch sieve and be retained on the No. 4 sieve.

Bin No. 4 - shall contain aggregates for which at least 75 percent will be of such size as to pass the 1 inch sieve and be retained on the 3/8 inch sieve.

Type "C" (Coarse-Graded Surface Course):

Bin No. 1 - shall contain aggregates of which 85 to 100 percent will pass the No. 10 sieve.

Bin No. 2 - shall contain aggregates of which at least 70 percent will be of such size as to pass the No. 4 sieve and be retained on the No. 10 sieve.

Bin No. 3 - shall contain aggregates for which at least 75 percent will be of such size as to pass the 3/8 inch sieve and be retained on the No. 4 sieve.

Bin No. 4 - shall contain aggregate of which at least 75 percent will be of such size as to pass the 7/8 inch sieve and will be retained on the 3/8 inch sieve.

Type "D" (Fine-Graded Surface Course):

Bin No. 1 - shall contain aggregates of which 85 to 100 percent will pass the No. 10 sieve.

Bin No. 2 - shall contain aggregates of which at least 70 percent will be of such size as to pass the No. 4 sieve and be retained on the No. 10 sieve.

Bin No. 3 - shall contain aggregates of which at least 75 percent will be of such size as to pass the 1/2 inch sieve and be retained on the No. 4 sieve.

Type "F" (Fine-Graded Mixture):

Bin No. 1 - shall contain aggregates of which 85 to 100 percent will pass the No. 10 sieve.

Bin No. 2 - shall contain aggregates of which at least 75 percent will be of such size as to pass the 3/8 inch sieve and be retained on the No. 10 sieve.

Aggregate Weigh Box and Batching Scale. The aggregate weigh box and batching scales shall be of sufficient capacity to hold and weigh a complete batch of aggregate. The weigh box and scales shall conform to the requirements of the TxDOT Item 520 "Weighing and Measuring Equipment".

Asphaltic Material Measuring System. If an asphaltic material bucket and scales are used, they shall be of sufficient capacity to hold and weigh a complete batch of aggregate. The weigh box and scales shall conform to the requirements of TxDOT Item 520, "Weighing and Measuring Equipment.

If pressure type flow meter is used to measure the asphaltic material, the requirements of TxDOT Item 520, "Weighing and Measuring Equipment", shall apply. This system shall include an automatic temperature compensation device to insure a constant percent by weight of asphaltic material in the mixture.

Provisions of a permanent nature shall be made for checking the accuracy of the asphaltic material-measuring device. The asphalt line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line near the temperature specified for the asphaltic material.

Mixer. The mixer shall be of the pugmill type and shall have a capacity of not less than 3,000 pounds (of natural-aggregate mixer) in a single batch, unless otherwise shown on the Plans. Any mixer that has a tendency to segregate the aggregate or fails to secure a thorough and uniform mixture with the asphaltic material shall not be used. All mixers shall be provided with an automatic timer that will lock the discharge doors of the mixer for the required mixing period. The dump door or doors and the shaft seals of the mixer shall be tight enough to prevent spilling of aggregate or mixture from the pugmill.

Surge-Storage System and Scales. A surge-storage system may be used to minimize the production interruptions during the normal day's operations. A device such as a gob hopper or other device approved by the City to prevent segregation in the surge-storage bin shall be used. The mixture shall be weighed upon discharge from the surge-storage system.

When a surge-storage system is used, scales shall be standard platform truck scales or other equipment such as weigh hopper (suspended) scales and shall conform to TxDOT Item 520, "Weighing and Measuring Equipment". If truck scales are used, they shall be placed at a location approved by the City. If other weighing equipment is used, the City may require weight checks by truck scales for the basis of approval of the equipment.

Recording Device and Record Printer. The mixture shall be weighed for payment. If a surge-storage system is used, an automatic recording device and a digital record printer shall be provided to indicate the date, project identification number, vehicle identification, total weight of the load, tare weight of the vehicle, the weight of asphaltic mixture in each load and the number of loads for the day, unless otherwise indicated on the Plans. When surge-storage is not used, batch weights will be used as the basis for payment and automatic recording devices and automatic digital record printers in accordance with TxDOT Item 520, "Weighing and Measuring Equipment", shall be required.

(b) Modified Weigh-Batch Type.

General. This plant is similar to the weigh-batch type plant. The hot bin screens shall be removed and the aggregate control is placed at the cold feeds. The cold feed bins shall be the same as those required for the drum-mix type plant.

Cold-Aggregate Bin Unit and Feed System. The number of bins in the cold-aggregate bin unit shall be equal to or greater than the number of stockpiles of individual materials to be used.

The bins shall be of sufficient size to store the amount of aggregate required to keep the plant in continuous operation and of proper design to prevent overflow of material from one bin to another. There shall be vertical partitions between each bin and on each end of the bins of sufficient height so that any overflow will be to the front and back and not allow overflow to the sides or between bins. Overflow that might occur shall not fall onto any feeder belt. When required by the City, an approved stationary-scalping screen shall be placed on top of the field sand bin to eliminate roots and other objectionable material. The feed system shall provide a uniform and continuous flow of aggregate in the desired proportion to the dryer. The Contractor shall furnish a chart indicating the calibration of each cold bin in accordance with Construction Bulletin C-14 or other methods of cold bin calibration acceptable to the City.

When mineral filler is used, as specified in Section 340.2 (1)(d), an additional bin shall be provided.

If RAP is used, a separate cold bin shall be required. The RAP feed system shall be equipped with a scalping screen to remove particles over two (2) inches in size. The cold bin system shall supply a uniform and proper amount of RAP to the mixture. The RAP may be added at the weigh box, the system shall include means acceptable to the City to verify that the correct amount of RAP is continuously being fed.

Scalping Screen. A scalping screen shall be required after the cold feeds and ahead of the hot aggregate surge bins.

Dryer. The dryer shall continually agitate the aggregate during heating. The temperature shall be controlled so that the aggregate will not be damaged in the drying and heating operations. The dryer shall be of sufficient size to keep the plant in continuous operation.

Screening and Proportioning. The hot aggregate shall not be separated into sizes after being dried. There shall be one (1) or more surge bins provided between the dryer and the weigh hopper. Surge bins shall be of sufficient size to hold enough combined aggregate for one complete batch of mixture.

Aggregate Weigh Box and Batching Scale. The aggregate weigh box and batching scales shall be of sufficient capacity to hold and weigh a complete batch of aggregate. The weigh box and scales shall conform to the requirements of TxDOT Item 520, "Weighing and Measuring Equipment".

Asphaltic Material Measuring System. If an asphaltic material bucket and scales are used, they shall be of sufficient capacity to hold and weigh the necessary asphaltic material for one batch. The bucket and scales shall conform to the requirements of TxDOT Item 520, "Weighing and Measuring Equipment".

If a pressure type flow meter is used to measure the asphaltic material, the requirements of TxDOT Item 520, "Weighing and Measuring Equipment", shall apply. This system shall include an automatic temperature compensation device to insure a constant percent by weight of asphaltic material in the mixture.

Provisions of a permanent nature shall be made for checking the accuracy of the asphaltic material measuring device. The asphalt line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line near the temperature specified for the asphaltic material.

Mixer. The mixer shall be of the pugmill type and shall have a capacity of not less than 3,000 pounds (of natural-aggregate mixture) in a single batch, unless otherwise shown on the Plans. Any mixer that has a tendency to segregate the aggregate or fails to secure thorough and uniform mixture with the asphaltic material shall not be used. All mixers shall be provided with an automatic timer that will lock the discharge doors of the mixer for the required mixing period. The dump door or doors and the shaft seals of the mixer shall be tight enough to prevent spilling of aggregate or mixture from the pugmill.

Surge-Storage System and Scales. A surge-storage system may be used to minimize the production interruptions during the normal day's operations. A device such as a gob hopper or other device approved by the City to prevent segregation in the surge-storage bin shall be used. The mixture shall be weighed upon discharge from the surge-storage system.

When a surge-storage system is used, scales shall be standard platform truck scales or other equipment such as weigh hopper (suspended) scales and shall conform to TxDOT Item 520, "Weighing and Measuring Equipment". If truck scales are used, they shall be placed at a location approved by the City. If other weighing equipment is used, the City may require weight checks by truck scales for the basis of approval of the equipment.

Recording Device and Record Printer. The mixture shall be weighed for payment. If a surge-storage system is used, an automatic recording device and a digital record printer shall be provided to indicate the date, project identification number, vehicle identification, total weight of the load, tare weight of the vehicle, the weight of asphaltic mixture in each load and the number of loads for the day, unless otherwise indicated on the Plans. When surge-storage is not used, batch weighs will be used as the basis for payment and automatic recording devices and automatic digital record printers in accordance with TxDOT Item 520, "Weighing and Measuring Equipment", shall be required.

(c) Drum Mix Type.

General. The plant shall be adequately designed and constructed for the process of mixing aggregates and asphalt. The plant shall be equipped with satisfactory conveyors, power units, aggregate-handling equipment and feed controls.

Cold-Aggregate Bin and Feed System. The number of bins in the cold-aggregate bin unit shall be equal to or greater than the number of stockpiles of individual materials to be used.

The bins shall be of sufficient size to store the amount of aggregate required to keep the plant in continuous operation and of proper design to prevent overflow of material from one bin to another. There shall be vertical partitions between each bin and on each end of the bins of sufficient height so that any overflow will be to the front and back and not allow overflow to the sides or between bins. Overflow that might occur shall not fall onto any feeder belt. When required by the City, an approved stationary-scalping screen shall be placed on top of the field sand bin to eliminate roots and other objectionable material. The feed system shall provide a uniform and continuous flow of aggregate in the desired proportion to the mixer. The Contractor shall furnish a chart indicating the calibration of each cold bin in accordance with Construction Bulletin C-14 or other methods of cold bin calibration acceptable to the City.

The system shall provide positive weight measurement of the combined cold aggregate feed by use of belt scales or other approved devices. Provisions of a permanent nature shall be made for checking the accuracy of the measuring device as required by TxDOT Item 520, "Weighing and Measuring Equipment". When a belt scale is used, mixture production shall be maintained so that the scale normally operates between 50 percent and 100 percent of its rated capacity. Belt scale operation below 50 percent of the rated capacity may be allowed by the City if accuracy checks show the scale to meet the requirements of TxDOT Item 520, "Weighing and Measuring Equipment", at the selected rate. It shall be satisfactorily demonstrated to the City that mixture uniformity and quality have not been adversely affected.

If RAP is used, a separate cold bin shall be required. The RAP feed system shall be equipped with a scalping screen to remove particles over two (2) inches in size prior to the weighing device. There shall be adequate cold bin controls to provide a uniform amount of RAP to the mixture.

When RAP is used, positive weight measurement of RAP shall be provided by the use of belt scales or other approved devices.

Scalping Screen. A scalping screen shall be required after the cold feeds and ahead of the combined aggregate belt scales.

Asphaltic Material Measuring System. An asphaltic material measuring device meeting the requirements of TxDOT Item 520, "Weighing and Measuring Equipment", shall be placed in the asphalt line leading to the mixer so that the cumulative amount of asphalt used can be accurately determined. Provisions of a permanent nature shall be made for checking the accuracy of the measuring device output. The asphalt line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line near the temperature specified for the asphaltic material. The measuring system shall include an automatic temperature compensation device to maintain a constant percent by weight of asphaltic material in the mixture.

Synchronization Equipment for Feed-Control Systems. The asphaltic material feed-control shall be coupled with the total aggregate weight-measuring device to automatically vary the asphalt-feed rate in order to maintain the required proportion.

Mixing System. The mixing system shall control the temperature so that the aggregate and asphalt will not be damaged in the drying, heating and mixing operations. A continuously recording thermometer shall be provided which will indicate the temperature of the mixture as it leaves the mixer.

Surge-Storage System and Scales. A surge-storage system shall used to minimize the production interruptions during the normal day's operations. A device such as a gob hopper or other device approved by the City to prevent segregation in the surge-storage bin shall be used. The mixture shall be weighed upon discharge from the surge-storage system.

Scales shall be standard platform truck scales or other equipment such as weigh hopper (suspended) scales and shall conform to TxDOT Item 520, "Weighing and Measuring Equipment". If truck scales are used, they shall be placed at a location approved by the City. If other weighing equipment is used, the City may require weight checks by truck scales for the basis of approval of the equipment.

Recording Device and Record Printer. Automatic recording devices and automatic digital record printers shall be provided to indicate the date, project identification number, vehicle identification, total weight of the load, tare weight of the vehicle, the weight of asphaltic mixture in each load and the number of loads for the day in accordance with TxDOT Item 520, "Weighing and Measuring Equipment", unless otherwise shown on the Plans.

(d) Specialized Recycling Type.

General. Alternate methods of heating may be used which will not abnormally age the asphalt cement. This type of plant shall be capable of continually producing a minimum of 150 tons per hour of completed asphalt mixture that will meet all the requirements of this specification.

Cold-Aggregate Bin Unit and Feed System. The cold aggregate feed system and controls shall meet all the requirements as listed under the drum-mix type plant.

Scalping Screen. A scalping screen shall be required after the cold feeds and ahead of the combined aggregate belt scales.

Dryer. The dryer shall continually agitate the RAP and aggregate during heating. The temperature shall be controlled so that the aggregate and asphalt will not be damaged in the drying and heating operations. The dryer shall be of sufficient size to keep the plant in continuous operation.

Asphaltic Material Measuring System. An asphaltic material measuring device meeting the requirements of Item 520, "Weighing and Measuring Equipment", shall be placed in the asphalt line leading to the mixer so that the cumulative amount of asphalt used can be accurately determined. Provisions of a permanent nature shall be made for checking the accuracy of the measuring device output. The asphalt line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line near the temperature specified for the asphaltic material. The measuring system shall include an automatic temperature compensation device to maintain a constant percent by weight of asphaltic material in the mixture.

Synchronization Equipment for Feed-Control Systems. The asphaltic material feed-control shall be coupled with the total aggregate weight-measuring device to automatically vary the asphalt-feed rate in order to maintain the required proportion.

Mixer. The mixer shall be of the continuous mechanical mixing type. Any mixer that has a tendency to segregate the mixture or fails to secure a thorough and uniform mixture shall not be used. A continuously recording thermometer shall be provided which will indicate the temperature of the mixture as it leaves the mixer.

Surge-Storage System and Scales. A surge-storage system shall be used to minimize the production interruptions during the normal day's operations. A device such as a gob hopper or other device approved by the City to prevent segregation in the surge-storage bin shall be used. The mixture shall be weighed upon discharge from the surge-storage system.

Scales shall be standard platform truck scales or other equipment such as weigh hopper (suspended) scales and shall conform to TxDOT Item 520, "Weighing and Measuring Equipment". If truck scales are used, they shall be placed at a location approved by the City. If other weighing equipment is used, the City may require weight checks by truck scales for the basis of approval of the equipment.

Recording Device and Record Printer. Automatic recording devices and automatic digital record printers shall be provided to indicate the date, project identification number, vehicle identification, total weight of the load, tare weight of the vehicle, the weight of asphaltic mixture in each load and the number of loads for the day in accordance with TxDOT Item 520, "Weighing and Measuring Equipment", unless otherwise shown on the Plans.

(3) Asphaltic Material Heating Equipment. Asphaltic material heating equipment shall be adequate to heat the required amount of asphaltic material to the desired temperature. The heating apparatus shall be equipped with a continuously recording thermometer with a 24-hour chart that will record the temperature of the asphaltic material at the location of highest temperature.

(4) Spreading and Finishing Machine. The spreading and finishing machine shall be approved by the City and shall be meet the requirements indicated below.

(a) Screed Unit. The spreading and finishing machine shall be equipped with a heated compacting screed. It shall produce a finished surface meeting the requirements of the typical cross sections and the surface tests.

Extensions added to the screed shall be provided with the same compacting action and heating capability as the main screed unit, except for use on variable depth tapered areas and/or as approved by the City.

The spreading and finishing machine shall be equipped with an approved automatic dual longitudinal screed control system and automatic transverse screed control system. The longitudinal controls shall be capable of operating from any longitudinal grade reference including a stringline, ski, mobile stringline, or matching shoe.

The Contractor shall furnish all equipment required for grade reference. Personnel trained in the use of this type of equipment shall maintain it in good operating condition.

The grade reference used by the Contractor may be of any type approved by the City. Control points, if required by the Plans, shall be established for the finished profile in accordance with TxDOT Item 5, "Control of the Work". These points shall be set at intervals not be exceed 50 feet. The Contractor shall set the grade reference from the control points. The grade reference shall have sufficient support so that the maximum deflection shall not exceed 1/16 inch between supports.

(b) Tractor Unit. The tractor unit shall be equipped with a hydraulic hitch sufficient in design and capacity to maintain contact between the rear wheels of the hauling equipment and the pusher rollers of the finishing machine while the mixture is being unloaded.

No portion of the weight of hauling equipment, other than the connection, shall be supported by the asphalt paver. No vibrations or other motions of the loading equipment, which could have a detrimental effect on the riding quality of the completed pavement, shall be transmitted to the paver.

The use of any vehicle which requires dumping directly into the finishing machine and which the finishing machine cannot push or propel to obtain the desired lines and grades without resorting to hand finishing will not be allowed.

(5) Material Transfer Equipment. Equipment to transfer mixture from the hauling units or the roadbed to the spreading and finishing machine will be allowed unless otherwise shown on the Plans. A specific type of material transfer equipment shall be required when shown on the Plans.

(a) Windrow Pick-up Equipment. Windrow pick-up equipment shall be constructed in such a manner that substantially all the mixture deposited on the roadbed is picked up and loaded into the spreading and finishing machine. The mixture shall not be contaminated with foreign material. The loading equipment shall be designed so that it does not interfere with the spreading and finishing machine in obtaining the required line, grade and surface without resorting to hand finishing.

(b) Material Feeding System. Material feeding systems shall be designed to provide a continuous flow of uniform mixture to the spreading and finishing machine. When use of a material feeding system is required on the Plans, it shall meet the storage capacity, remixing capability, or other requirements shown on the Plans.

(6) Motor Grader. The motor grader, when used, shall be a self-propelled power motor grader and shall be equipped with smooth tread pneumatic tired wheels unless otherwise directed. It shall have a blade length of not less than 12 feet and a wheelbase of not less than 16 feet.

(7) Rollers. Rollers provided shall meet the requirements for their type as follows:

(a) Pneumatic Tire Rollers. The roller shall be acceptable medium pneumatic tire roller conforming to the requirements of Item 213, "Rolling (Pneumatic Tire)", Type B, unless otherwise specified on the Plans. Pneumatic-tire rollers used for compaction shall provide a minimum 80-psi ground contact pressure. When used for kneading and sealing the surface only, they shall provide a minimum of 55-psi ground contact pressure.

(b) Two Axle Tandem Roller. The roller shall be an acceptable self-propelled tandem roller weighing not less than eight (8) tons.

(c) Three Wheel Roller. This roller shall be an acceptable self-propelled three-wheel roller weighing not less than ten (10) tons.

(d) Three Axle Tandem Roller. This roller shall be an acceptable self-propelled three-wheel roller weighing not less than ten (10) tons.

(e) Trench Roller. This roller shall be an acceptable self-propelled trench roller equipped with a sprinkler for keeping the wheels wet and an adjustable road wheel so that the roller may be kept level during rolling. The drive wheel shall be not less than 20 inches wide. The roller under working conditions shall produce not less than 325 pounds per linear inch of roller width and be so geared that a speed of approximately 1.8 miles per hour is obtained in low gear.

(f) Vibratory Steel-Wheel Roller. This roller shall have a minimum weight of six (6) tons. The compactor shall be equipped with amplitude and frequency controls and shall be specifically designed to compact the material on which it is used.

(8) Straightedges and Templates. When directed by the City, the Contractor shall provide acceptable ten (10) foot straightedges for surface testing. Satisfactory templates shall be provided as required by the City.

(9) Alternate Equipment. When permitted by the City, equipment other than that specified which will consistently produce satisfactory results may be used.

340.5. STOCKPILING, STORAGE AND MIXING:

(1) Stockpiling of Aggregates.

(a) Weigh-Batch Plant. Prior to Stockpiling of aggregates, the area shall be cleaned of trash, weeds, grass and be relatively smooth and well drained. The stockpiling shall be done in a manner that will minimize aggregate degradation, segregation, mixing of one stockpile with another, and will not allow contamination with foreign material.

The plant shall have at least a two-day supply of aggregates on hand before production can begin and at least a two-day supply shall be maintained through the course of the project, unless otherwise directed by the City.

No stockpile shall contain aggregate from more than one source.

Coarse aggregates for mixture Types "A", "B", and "C" shall be separated into at least two stockpiles of different gradation, such as a large-coarse-aggregate and a small-coarse-aggregate stockpile, except when the use of large percentages of RAP preclude the need for two virgin coarse aggregate stockpiles.

When shown on the Plans, coarse aggregates for Type "D" mixtures shall also be separated into at least two stockpiles.

No coarse-aggregate stockpile shall contain more than 15 percent by weight of material that will pass a No. 10 sieve.

Fine-aggregate stockpiles may contain coarse aggregate in amounts up to 20 percent by weight. This requirement does not apply to stone screening stockpiles, which must met the gradation requirements shown in Section 340.2 (1)(c), unless otherwise shown on the Plans.

Prior to starting RAP stockpiling operations, the Contractor shall develop and submit in writing to the City an acceptable stockpile production procedure and management plan, which will ensure that a homogeneous stockpile of RAP is available. Stockpiles of contractor-owned RAP material shall be completely established at the plant site prior to submission of mixture design samples and shall be of sufficient quantity to meet the material requirements of the project for which they are prepared. When shown on the Plans, plant site stockpiles composed of RAP from designated sources shall be of the minimum size shown on the Plans prior to submission of mixture design samples.

When required by the City, additional material shall not be added to stockpiles that have previously been sampled for approval.

Equipment of an acceptable size and type shall be furnished to work the stockpiles and prevent segregation and degradation of the aggregates.

(b) Modified Weigh-Batch Plant. The stockpiling requirements for aggregate shall be the same as required for a drum-mix type plant.

(c) Drum-Mix Plant. When a drum-mix plant is used, the following stockpiling requirements for coarse aggregates shall apply in addition to the aggregate stockpiling requirements listed under Section 340.5. (d)(a).

Once a job mix design has been established in accordance with Section 340.3, the virgin coarse aggregates delivered to the stockpiles shall not vary on any grading size fraction by more than plus or minus eight (8) percentage points from the percentage found in the samples submitted by the Contractor and upon which the job-mix formula was based. Should the gradation of virgin coarse aggregates in the stockpiles vary by more than the allowed tolerance, the City may stop production. If production is stopped, new aggregates shall be furnished that meet the gradations of the aggregates submitted for the design job-mix formula or a new mix design shall be formulated in accordance with Section 340.3.

When the volume of production from a commercial plant makes sampling of all coarse aggregate delivered to the stockpiles impractical, cold feeds will be sampled to determine stockpile uniformity. Should this sampling prove the stockpiles non-uniform beyond the acceptable tolerance, separate stockpiles which meet these specifications may be required.

(d) Specialized Recycling Plant. The stockpiling requirements for aggregate shall be the same as required for drum-mix type plant.

(2) Storage and Heating of Asphaltic Materials. The asphaltic material storage capacity shall be ample to meet the requirements of the plant. Asphalt shall not be heated to temperature in excess of that specified in the Item 300, "Asphalts, Oils, and Emulsions". All equipment used in the storage and handling of asphaltic material shall be kept in a clean condition at all times and shall be operated in such manner that there will be no contamination with foreign matter.

(3) Feeding and Drying of Aggregate. The feeding of various sizes of aggregate and RAP, if applicable, to the dryer shall be done through the cold aggregate bins and the proportioning device in such a manner that a uniform and constant flow of materials in the required proportions will be maintained. The aggregate shall be dried and heated to the temperature necessary to produce a mixture having the specified temperature.

(4) Mixing and Storage.

(a) Weigh-batch Mixer. In introducing the batch into the mixer, all aggregate shall be introduced first and shall be mixed thoroughly for a period of five (5) seconds to uniformly distribute the various sizes throughout the batch before the asphaltic material is added. The asphaltic material shall then be added and the mixing continued for a wet mixing period of not less than 15 seconds. The mixing period shall be increased if, in the opinion of the City, the mixture is not uniform or the aggregates are not properly coated.

Temporary storing or holding of the asphaltic mixture by the surge-storage system will be permitted during the normal day's operation. Overnight storage will not be permitted unless authorized in the Plans or by the City. The mixture coming out of the surge-storage bin shall be of equal quality to that coming out of the mixer.

(b) Modified Weigh-Batch Plant. The mixing and storage requirements shall be the same as is required for a standard weigh-batch plant.

(c) Drum Mix Plant. The amount of aggregate and asphaltic material entering the mixer and the rate of travel through the mixing unit shall be so coordinated that a uniform mixture of the specified grading and asphalt content will be produced.

Temporary storing or holding of the asphaltic mixture by the surge-storage system will be required during the normal day's operation. Overnight storage will not be permitted unless authorized in the Plans or by the City. The mixture coming out of the surge-storage bin shall be of equal quality to that coming out of the mixer.

(d) Specialized Recycling Plant. The mixing and storage requirements shall be the same as that stated for the drum-mix plant.

(e) Discharge Temperature. The City will select the target discharge temperature of the mixture between 250° F and 350° F. The mixture, when discharged from the mixer, shall not vary from this selected temperature more than 25° F, but in no case shall the temperature exceed 360° F.

(f) Moisture Content. The mixture produced from each type of mixer shall have a moisture content not greater than 1 percent by weight when discharged from the mixer, unless otherwise shown on the Plans and/or specified by the City. The moisture content shall be determined in accordance with Test Method Tex-212-F.

(g) RAP. If RAP is used, it shall be mixed and blended so that there is no evidence of unseparated particles in the mixture as it leaves the mixer.

340.6. CONSTRUCTION METHODS.

(1) General. It shall be the responsibility of the Contractor to produce, transport, place and compact the specified paving mixture in accordance the requirements herein.
The asphaltic mixture, when placed with a spreading and finishing machine or the tack coat shall not be placed when the air temperature is below 50° F and is falling, but it may be placed when the air temperature is above 40° F and is rising.

The asphaltic mixture, when placed with a motor grader, shall not be placed when the air temperature is below 60°F and is falling, but it may be placed when the air temperature is above 50° F and is rising.

The air temperature shall be taken in the shade away from artificial heat.

Mat thicknesses of 1 1/2 inches and less shall not be placed when the temperature of the surface on which the mat is to be placed is below 50°F.

Additional surface temperature requirements may be shown on the Plans.

It is further provided that the tack coat or asphaltic mixture shall be placed only when the humidity, general weather conditions and temperature and moisture condition of the base, in the opinion of the City, are suitable.

If, after being discharged from the mixer and prior to placing, the temperature of the asphaltic mixture is 50°F or more below the selected discharge temperature established by the City, all or any part of the load may be rejected and payment will not be made for the rejected material.

(2) Tack Coat. The surface upon which the tack coat is to be placed shall be cleaned thoroughly to the satisfaction of the City. The surface shall be given a uniform application of tack coat using asphaltic materials of this specification. This 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 City. Where the mixture will adhere to the surface on which it is to be placed without the use of a tack coat, the tack coat may be eliminated by the City. All contact surfaces of curbs and structures and all joints shall be painted with a thin uniform application of tack coat. During the application of tack coat, care shall be taken to prevent splattering of adjacent pavement, curb and gutter and structures. The tack coat shall be rolled with a pneumatic tire roller when directed by the City.

(3) Transporting Asphaltic Concrete. The asphaltic mixture 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 is placed and all rolling completed during daylight hours unless otherwise shown on the Plans. In cool weather or for long hauls, covering and insulating of the truck bodies may be required. If necessary, to prevent mixture from adhering to the body the inside of the truck may be given a light coating of release agent satisfactory to the City.

(4) Placing.

(a) The asphaltic mixture shall be dumped and spread on the approved prepared surface with the specified spreading and finishing machine. When properly compacted, the finished pavement shall be smooth, of uniform texture and density and shall meet the requirements of the typical cross sections and the surface tests. In addition, the placing of the asphaltic mixture shall be done without tearing, shoving, gouging or segregating the mixture and without producing streaks in the mat.

Unloading into the finishing machine shall be controlled so that bouncing or jarring the spreading and finishing machine shall not occur and the required lines and grades shall be obtained without resorting to hand finishing, except as shown under Section 340.6.(4)(d).

Unless otherwise shown on the Plans, dumping of the asphaltic mixture in a windrow and then placing the mixture in the finishing machine with windrow pick-up equipment will be permitted. The windrow pick-up equipment shall be operated in such a manner that substantially all the mixture deposited on the roadbed is picked up and loaded into the finishing machine without contamination by foreign material. The windrow pick-up equipment will be so operated that the finishing machine will obtain the required line, grade and surface without resorting to hand finishing. Any operation of the windrow pick-up equipment resulting in the accumulation and subsequent shedding of accumulated material into the asphaltic mixture will not be permitted.

(b) When approved by the City, level-up courses may be spread with a motor grader.

(c) The spreading and finishing machine shall be operated at a uniform forward speed consistent with the plant production rate, hauling capability, and roller train capacity to result in a continuous operation. The speed shall be slow enough that stopping between trucks is not ordinarily required. If, in the opinion of the City, sporadic delivery of material is adversely affecting the mat, the City may require paving operations to cease until acceptable methods are provided to minimize starting and stopping of the paver.

The hopper flow gates of the spreading and finishing machine shall be adjusted to provide an adequate and consistent flow of material. These shall result in enough material being delivered to the augers so that they are operating approximately 85 percent of the time or more. The augers shall provide means to supply adequate flow of material to the center of the paver. Augers shall supply an adequate flow of material for the full width of the mat, as approved by the City. Augers should be kept approximately one-half to three-quarters full of mixture at all times during the paving operation.

(d) When the asphaltic mixture is placed in a narrow strip along the edge of an existing pavement, or used to level up small areas of an existing pavement, or placed in small irregular areas where the use of a finishing machine is not practical, the finishing machine may be eliminated when authorized by the City.

(e) Adjacent to flush curbs, gutters and structures, the surface shall be finished uniformly high so that when compacted it will be slightly above the edge of the curb or structure.

(f) Construction joints of successive courses of asphaltic material shall be offset at least six (6) inches. Construction joints on surface courses shall coincide with lane lines, or as directed by the City.

(g) If a pattern of surface irregularities or segregation is detected, the Contractor shall make an investigation into the causes and immediately take the necessary corrective action. With the approval of the City, placement may continue for no more than one full production day from the time the Contractor is first notified and while corrective actions are being taken. If the problem still exists after that time, paving shall cease until the Contractor further investigates the causes and the City approves further corrective action to be taken.

(5) Compacting.

(a) The pavement shall be compacted thoroughly and uniformly with the necessary rollers to obtain the compaction and cross section of the finished paving mixture meeting the requirements of the Plans and specifications.

(b) When rolling with the three wheel, tandem, or vibratory rollers, rolling shall start by first rolling the joint with the adjacent pavement and then continue by rolling longitudinally at the sides and proceed toward the center of the pavement, overlapping on successive trips by at least one foot, unless otherwise directed by the City. Alternate trips of the roller shall be slightly different in length. On super-elevated curves, rolling shall begin at the low side and progress toward the high side unless otherwise directed by the City.

When rolling with vibratory steel wheel rollers, equipment operation shall be in accordance with Item 217, "Rolling (Vibratory)", and the manufacturer's recommendations, unless otherwise directed by the City. Vibratory rollers shall not be left vibrating while not rolling or when changing directions. Unless otherwise shown on the Plans or approved by the City, vibratory rollers shall not be allowed in the vibrating mode on mats with a plan depth of less than 1-1/2 inches.

The motion of the rollers shall be slow enough to avoid other than usual initial displacement of the mixture. If any displacement occurs, it shall be corrected to the satisfaction of the City. The roller shall not be allowed to stand on pavement, which has not been fully compacted. To prevent adhesion of the surface mixture to the steel-wheel rollers, the wheels shall be kept thoroughly moistened with water, but an excess of water will not be permitted. Necessary precautions shall be taken to prevent the dropping of diesel, gasoline, oil, grease or other foreign matter on the pavement, either when the rollers are in operation or when standing.

(c) 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.

(d) Rolling with a trench roller will be required on widened areas, in trenches and other limited areas where satisfactory compaction cannot be obtained with the approved rollers.

(6) In-Place Compaction Control. In-place compaction control is required for all mixtures. Unless otherwise shown on the Plans, air void control shall be required.

(a) Air Void Control. The Contractor shall be responsible for determining the number and type of rollers to be used to obtain compaction to within the air void range required herein. The rollers shall be operated in accordance with the requirements of this specification and as approved by the City.

Unless otherwise shown on the Plans, rolling with pneumatic-tire roller to seal the surface shall be provided. Rolling with a tandem or other steel-wheel roller shall be provided if required to iron out any roller marks.

Asphaltic concrete shall be placed and compacted to contain from five (5) to nine (9) percent air voids. The percent air voids will be calculated using the maximum theoretical specific gravity of the mixture determined according to Texas State Department of Transportation Test Method Tex-227-F. Roadway specimens, which shall be either cores or sections of asphaltic pavement, will be tested according to Test Method Tex-207-F. The nuclear-density gauge or methods which correlate satisfactorily with results obtained from project roadway specimens may be used when approved by the City. Unless otherwise shown on the Plans, The Contractor shall be responsible for obtaining the required roadway specimens at his expense and in a manner and at locations selected by the City.

If the percent air voids in the compacted placement is greater than nine (9) percent but is ten (10) percent or less, production may proceed with subsequent changes in the construction operations and/or mixture. If the air void content is not reduced to between five (5) and nine (9) percent within one production day from the time the Contractor is notified, production shall cease. At that point, a test section as described below shall be required.

If the percent air voids is more than ten (10) percent, production shall cease immediately and a test section shall be required as described below.

In either case, the Contractor shall only be allowed to place a test section of one lane width, not to exceed 0.2 mile in length, to demonstrate that compaction to between five (5) and nine (9) percent air voids can be obtained. This procedure will continue until a test section with five (5) to nine (9) percent air voids can be produced. Only (2) two test sections per day will be allowed. When a test section producing satisfactory air void content is placed, full production may then resume.

Increasing the asphalt content of the mixture in order to reduce pavement air voids will not be allowed.

If the percent air voids is determined to be less than five (5) percent, immediate adjustments shall be made to the plant production by the Contractor, as approved by the City, within the tolerances as outlined in Section 340.3.(4), so that an adequate air void level results.

The Contractor is encouraged to perform supplemental compaction testing for his own information.

(b) Ordinary Compaction Control. When the requirement of air void control has been removed by plan note, one three-wheel roller, one pneumatic-tire roller, and one tandem roller shall be furnished for each compaction operation except as provided below or approved by the City. The City may waive the use of a tandem roller when the surface is already adequately smooth and further steel-wheel rolling is shown to be ineffective. With approval of the City, the Contractor may substitute a vibratory roller for the three-wheel roller and/or the tandem roller. Use of at least one pneumatic-tire roller is required. Additional or heavier rollers shall be furnished if required by the City.

Rolling patterns shall be established by the Contractor as outlined in Test Method Tex-207-F, Part IV, to achieve the maximum compaction, unless otherwise directed by the City. The selected rolling pattern shall be followed unless changes in the mixture or placement conditions occur which affect compaction. When changes in the mixture or placement conditions occur, a new rolling pattern shall be established.

(c) Compaction Cessation Temperature. Regardless of the method required for in-place compaction control, all rolling for compaction shall be completed before the mixture temperature drops below 175^{o} F.

(7) Opening to Traffic. The pavement shall be opened to traffic when directed by the City. The Contractor's attention is directed to the fact that all construction traffic allowed on pavement open to the public will be subject to the State laws governing traffic on highways.

If the surface ravels, flushes, ruts or deteriorates in any manner prior to final acceptance of the work, it will be the Contractor's responsibility to correct this condition at his expense to the satisfaction of the City and in conformance with the requirements of this specification.

340.7. MEASUREMENT.

The quantity of Asphaltic concrete will be measured by the composite weight or composite volumetric method.

(1) Composite Weight Method. Asphaltic concrete will be measured by the ton of 2000 pounds of the composite "Asphaltic Concrete" of the type actually used in the completed and accepted work in accordance with the Plans and specifications for the project. The composite asphaltic concrete mixture is hereby defined as the asphalt, aggregate, RAP and additives as noted in the Plans and/or approved by the City.

If mixing is done by a drum mix plant or specialized recycling plant, measurement will be made on scales as specified herein.

If mixing is done by weigh-batch plant or modified weigh-batch plant, measurement will be determined on the batch scales unless surge-storage is used. Records of the number of batches, batch design and the weight of the composite "Asphaltic Concrete" shall be kept. Where surge-storage is used, measurement of material taken from the surge-storage bin will be made on truck scales or suspended hopper scales.

(2) Composite Volumetric Method. The asphaltic concrete will be measured by the cubic yard of compacted "Asphaltic Concrete" of the type actually used in the completed and accepted work in accordance with the Plans and specifications for the project. The composite asphaltic concrete mixture is hereby defined as the asphalt, aggregate, RAP and additives as noted in the Plans and/or approved by the City. The volume of the composite asphaltic concrete mixture shall be calculated by the following formula:

$$V = \frac{W}{62.4\ (27)\ Ga}$$

V = Cubic yards of compacted "Asphaltic Concrete"
W = Total weight of asphaltic concrete in pounds
Ga = Average actual specific gravity of three molded specimens as prepared by Test Method Tex-206-F and determined in accordance with Test Method Tex-207-F.

If mixing is done by a drum-mix plant or specialized recycling plant, the weight "W" will be determined by scales as specified herein.

If mixing is done by a weigh-batch plant or modified weigh-batch plant and surge-storage is not used, weight will be determined by batch scales and records of the number of batches, batch designs and weight of asphalt and aggregate shall be kept. Where surge-storage is used, measurement of the material taken from the surge-storage bin will be made on truck scales or suspended hopper scales.

340.8 PAYMENT.

(1) 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 "Asphaltic Concrete" of the type specified.

Measurement Method	Bid Item	Unit of Measure
Composite Weight	Asphaltic Concrete	Ton
Composite Volumetric	Asphaltic Concrete	Cubic Yard

The payment based on the unit bid price shall be full compensation for quarrying, furnishing all materials, additives, freight involved, for all heating, mixing, hauling, cleaning the existing base course or pavement, tack coat, placing, rolling and finishing asphaltic concrete mixture, transporting RAP from designated sources, transporting any excess RAP to locations shown on the Plans, and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

(2) All templates, straightedges, core drilling equipment, scales and other weighing and measuring devices necessary for the proper construction, measuring and checking of the work shall be furnished, operated and maintained by the Contractor at his expense.

(3) City-owned RAP from sources designated on the Plans will be available at no cost to the Contractor.

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 400

EXCAVATION AND BACKFILL FOR STRUCTURES

400.1 DESCRIPTION.

This Item shall govern for the excavation bedding, backfill and/or Portland Cement Stabilized Backfill required for the construction of all structures. This Item shall also govern for any necessary sloping, pumping or bailing, for drainage, and for all sheeting and bracing of excavation walls up to five feet in depth. Excavation greater than five (5) feet in depth shall be protected as specified in TxDOT Item 402, "Trench Excavation Protection" or TxDOT Item 403, " Temporary Special Shoring". Unless otherwise provided, the work included herein shall provide for the removal of old structures or portions thereof (abutments, wingwalls, piers, house foundations; old sewers, sewer appurtenances, etc.), trees and all other obstructions to the proposed construction, the blocking of the ends of abandoned sewers cut and left in place, and the protection of existing utilities. Also governed by this Item are the cutting and restoration of pavement and base courses, the construction and removal of any required cofferdams, the hauling and disposition of surplus materials and the bridging of trenches and other provisions for maintenance of traffic or access.

400.2 EXCAVATION.

(1) General. Excavation shall conform to the lines and grades shown on the Plans or as directed by the City.

When trench and/or negative projecting conditions for concrete pipe culverts are required by design, an excavation diagram will be shown on the Plans. These limits of excavation shall not be exceeded.

(a) Disposal of Excavation. All materials from excavation operations not required for backfilling and that are considered satisfactory, may be placed in embankment in accordance with Item 132, "Embankment". All excess material or material not satisfactory for use in Embankment will become the property of the Contractor. All surplus material shall be removed from the work site promptly following the completion of the portion of the structure involved and disposed of in a manner satisfactory to the City and by permit from the City.

Whenever excavation is made for installing structures across private property or beyond the limits of the embankment, the top soil removed in the excavation shall be kept separate and replaced, as nearly as feasible.

(b) Excavation in Streets. Where structures are installed in streets, highways or other paved areas, the work shall include the cutting of pavement and base to neat lines and the restoration of pavement structure after structural excavation and backfill are completed. The type and thickness of replacement materials shall be as shown on the Plans. Any work done or any damage to base

and/or pavement incurred outside the limits shown on the Plans or authorized by the City, will not be measured for payment, but shall be restored at the Contractor's expense. Maintenance and control of traffic shall be in accordance with the approved traffic control plan and Manual on Uniform Traffic Control Devices.

(c) Protection of Utilities. The **Contractor** shall conduct his work with a minimum disturbance of existing utilities and it shall be his responsibility to coordinate all work in or near the utilities with the utility owners. The Contractor shall inform utility owners sufficiently in advance of his operations to enable them to identify and locate, reroute, provide temporary detours, or to make other adjustments to utility lines in order that work may proceed with a minimum of delay. The Contractor shall cooperate with all utility owners concerned for any utility adjustments necessary.

Particular care shall be exercised to avoid the cutting or damaging of underground utility lines that are to remain in place. Such lines if damaged shall be restored promptly. When active sanitary sewer lines are cut during excavation operations temporary flumes shall be provided across the excavation, while open, and the lines shall be restored when the backfilling has progressed to the original bedding lines of the cut sewer.

(d) Removing Old or Abandoned Structures. When old or abandoned structures or foundations are encountered in the excavation, such obstructions shall be removed for the full width of the excavation and to a depth of one (1) foot below the bottom of the excavation. When old inlets or manholes are encountered and no plan provision is made for adjustment or connection to the new structures, such manholes and inlets shall be removed completely to a depth one (1) foot below the bottom of the excavation. In each instance, the bottom of the excavation shall be restored to grade by backfilling and compacting by the methods provided hereinafter for backfill. Where the excavation cuts through abandoned sewers, these sewers shall be removed as required to clear the new structure and plugged in a manner approved by the City.

(e) Dewatering of Excavation Area. Structures shall not be constructed or laid in the presence of water unless approved by the City. Setting of precast members, placement of concrete, or pipe placing operations shall be performed on a dry firm bed. This shall be accomplished by removal of water from the surface of the bed by bailing, pumping, wellpoint installation, deep wells, drench drains, or any other method approved by the City.

For foundations placed in the presence of water, when approved by the City, pumping or bailing from the interior of any foundation enclosure shall be done in a manner which precludes the possibility of movement of water through or alongside any concrete being placed. No pumping or bailing will be permitted during the placing of structural concrete or for a period of at least 36 hours thereafter, unless from a suitable sump separated from the concrete work. Pumping or bailing during placement of seal concrete shall be only to the extent necessary to maintain a static head of water within the cofferdam. Pumping or bailing to dewater a sealed cofferdam shall not be started until the seal has aged at least 36 hours.

In the event that the excavation cannot be dewatered to the point where the subgrade is free of mud, or it is difficult to keep the reinforcing steel clean in cast-in-place structures, a special material shall be used in the bottom of the excavation. Such special material shall be a minimum depth of three

inches and shall consist of a lean concrete mixture (not less than three (3) sacks of cement per cubic yard), or other material approved by the City.

(2) Bridge Foundations and Retaining Walls. To determine the adequacy of a proposed foundation, the City may require the Contractor to make soundings or take cores to determine the character of the subgrade materials. The maximum depth of soundings or cores will not exceed five (5) feet below the proposed footing grade.

Care shall be taken not to disturb the material below the bottom of footing grade. Backfilling in a foundation to compensate for excavation which has extended below grade will not be permitted. Such areas below grade shall be filled with concrete at the time the footing is placed. The additional concrete involved shall be at the Contractor's expense.

Unless otherwise required herein or on the Plans, rock or other hard foundation material shall be free from all loose material, clean, and cut to a firm surface which may be level, stepped, or serrated, as directed by the City. All seams shall be cleaned out and filled with concrete at the time the footing is placed.

When the material encountered at footing grade of a retaining wall, bridge bent or pier is found to be partially of rock or incompressible material and partially of a compressible material, the foundation shall not be placed until the City has inspected the footing and authorized necessary changes to provide a uniform bearing condition.

(3) Culverts. For all single and multiple box culverts, pipe culverts, pipe arch culverts, long span structural plate structures, box sewers, and pipe sewers where the soil encountered at established footing grade is an unstable or incompressible material, the following procedure shall be used unless other methods are called for on the Plans:

Unstable material shall be removed to a depth not to exceed two (2) feet below the footing of the structure unless additional depth is authorized by the City. All soil removed shall be replaced with stable material in uniform layers not to exceed eight (8) inches in depth (loose measurement). Each layer shall have sufficient moisture to be compacted by rolling or tamping as required to provide a stable foundation for the structure.

When it is not feasible to construct a stable footing as outlined above, the Contractor shall use special materials, such as flexible base, cement stabilized base, cement stabilized backfill or other material, as directed by the City. This work will be paid for as provided in Article 400.8. Special material used, or additional excavation made, for the Contractor's convenience to expedite the work, will be at the Contractor's expense.

When the material encountered at the footing grade of a structure is found to be rock, partially rock or other incompressible material, the incompressible material shall be removed to a depth of six (6) inches below the footing grade and backfilled with a compressible material approved by the City and compacted in accordance with Section 400.5.

(4) Trench. Unless otherwise shown on the Plans, all sewer pipe structures shall be constructed in an open cut with vertical sides to a point one (1) foot above the pipe. When site conditions or the Plans do not prohibit the sloping of the cut, the excavation one (1) foot above the pipe may be

stepped and/or the sides laid back to a stable slope. Required vertical sides shall be sheeted and braced when necessary to maintain the required vertical excavation throughout the construction period.

For all pipe sewers to be constructed in fill above natural ground, the embankment shall first be constructed to an elevation not less than one (1) foot above the top of the pipe, after which excavation for the pipe shall be made as noted above.

Unstable or incompressible material shall be removed in accordance with Section 400.2(3). For unstable trench conditions requiring outside forms, seals, sheeting and bracing, or where ground water is encountered, any additional excavation and backfill required shall be done at the Contractor's expense for trenches up to five (5) feet in depth.

400.3 COFFERDAMS.

The term cofferdam designates any temporary or removable structure constructed to hold the surrounding earth, water, or both out of the excavation, whether the structure is formed of soil, timber, steel, concrete, or a combination of these. The "cofferdam" shall also include the use of pumping wells or well points used for the same purpose. The cost of cofferdams shall be included in the price bid for excavation except where temporary special shoring is shown on the Plans to provide excavation protection.

For sheet pile or other types of cofferdams, which require internal bracing, the Contractor shall submit details and design calculations bearing the seal of a Registered Professional City for review. The maximum stresses shall not exceed 125 percent of the working allowable stresses used by the City Engineering Department for the design of structures. The interior dimensions of cofferdams shall provide sufficient clearance for the construction, inspection (inside and outside), and removal of any required forms and to permit pumping outside the forms. In general, sheet pile cofferdams shall extend well below the bottom of the footings and any concrete seal and shall be well braced and as watertight as practicable.

When the City judges it to be impractical to de-water a cofferdam and a concrete seal is to be placed around piling driven therein, the excavation shall be deep enough to allow for swell of the material during pile driving operations. After driving the piling, all swelling material shall be removed to the bottom of the seal grade. Where it is possible to de-water the cofferdam without placing a seal, the foundation material shall be removed to exact footing grades after piling are driven. Backfilling a foundation to compensate for excavation, which has been extended below grade, will not be permitted. Such areas below grade shall be filled with concrete at the time the seals or footings are placed. The additional concrete quantities necessary to compensate for excavation below grade shall be at the Contractor's expense.

Unless otherwise provided, the Contractor shall remove cofferdams after the completion of the substructure without disturbing or damaging the structure.

400.4 SHAPING AND BEDDING.

For precast pipe and box sections, the excavation shall be undercut a minimum depth sufficient to accommodate the class of bedding indicated on the Plans and conforming to the bedding requirement of this Item. Where cement stabilized backfill is indicated on the Plans, the excavation shall be undercut a minimum of four (4) inches and backfilled with stabilized material to support the pipe at the required grade.

Three classes of bedding for trench or embankment conditions are shown in Figures 1, 2, and 3. Bedding shall be in accordance with Class C bedding unless otherwise shown on the Plans. The City may require the use of a template to secure reasonably accurate shaping of the foundation material.

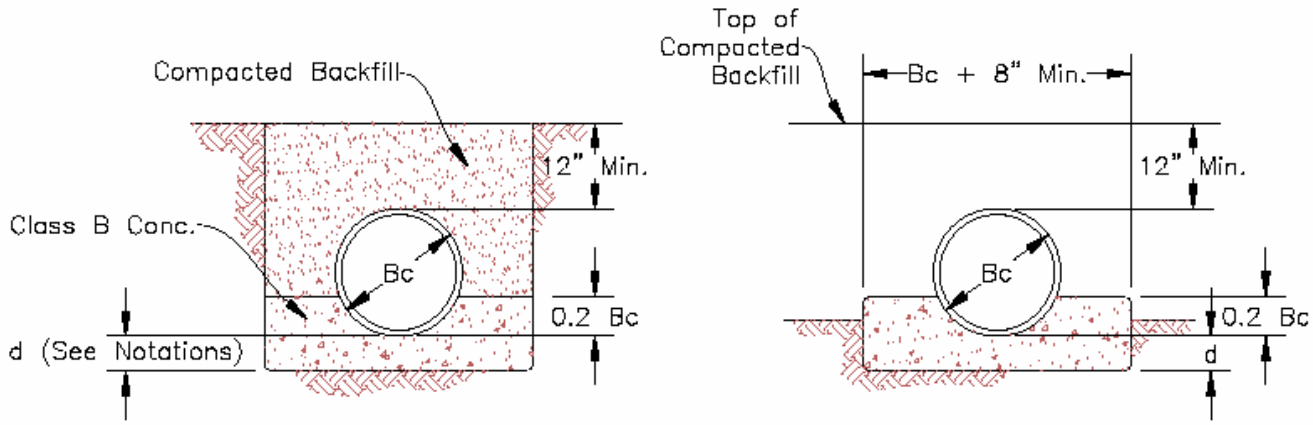
DEPTH OF BEDDING MATERIAL BELOW PIPE

D	d (Min.)
27" & smaller	3
30" to 60"	4
66" & larger	6

LEGEND

Bc = Outside Diameter or Horizontal Dimension
B'c = Vertical Dimension
H = Backfill Cover Above Top of Pipe in Inches
D = Inside Diameter of Pipe
d = Depth of Bedding Material Below Pipe in Inches

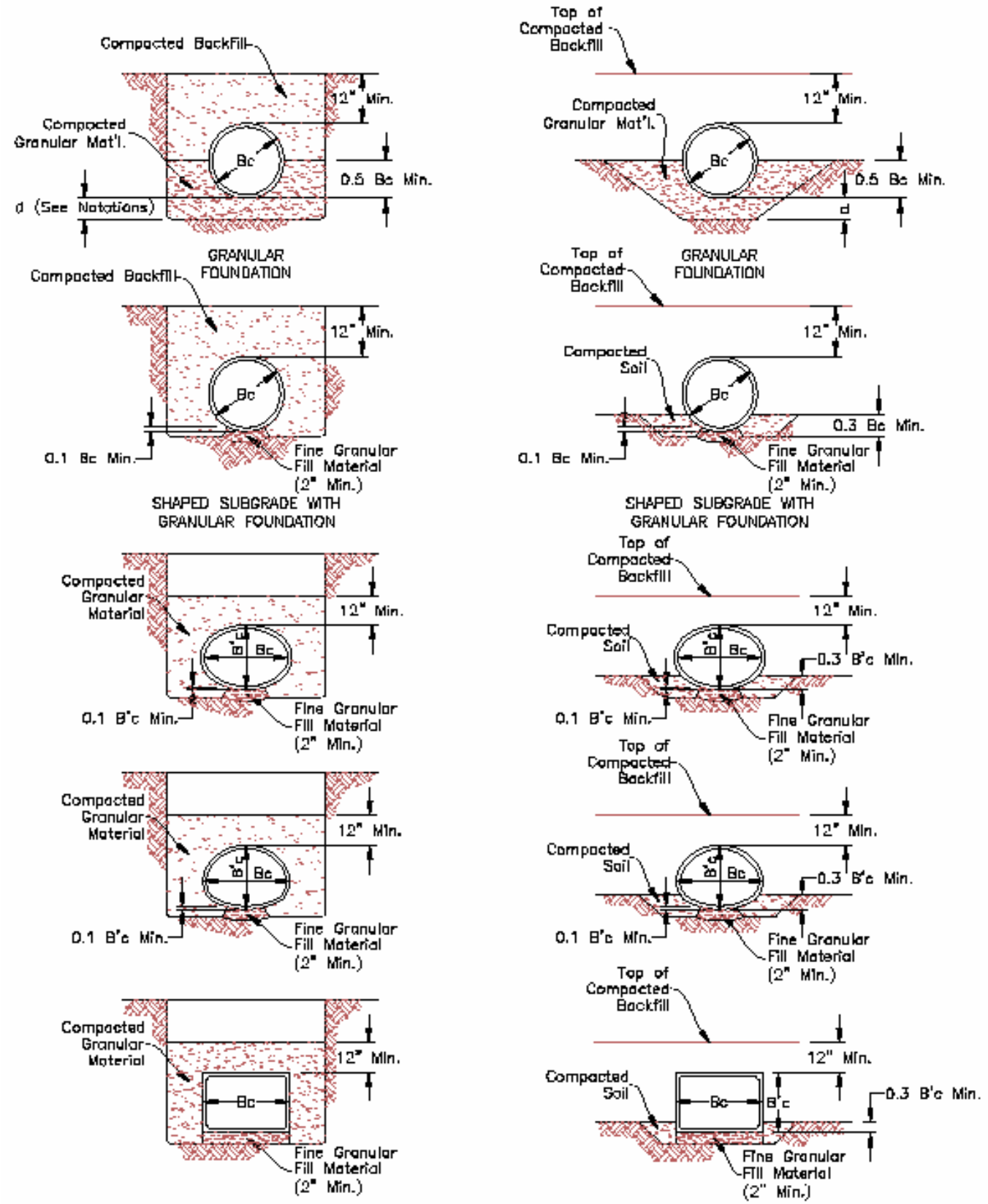
NOTATIONS FOR FIGURES 1, 2 & 3

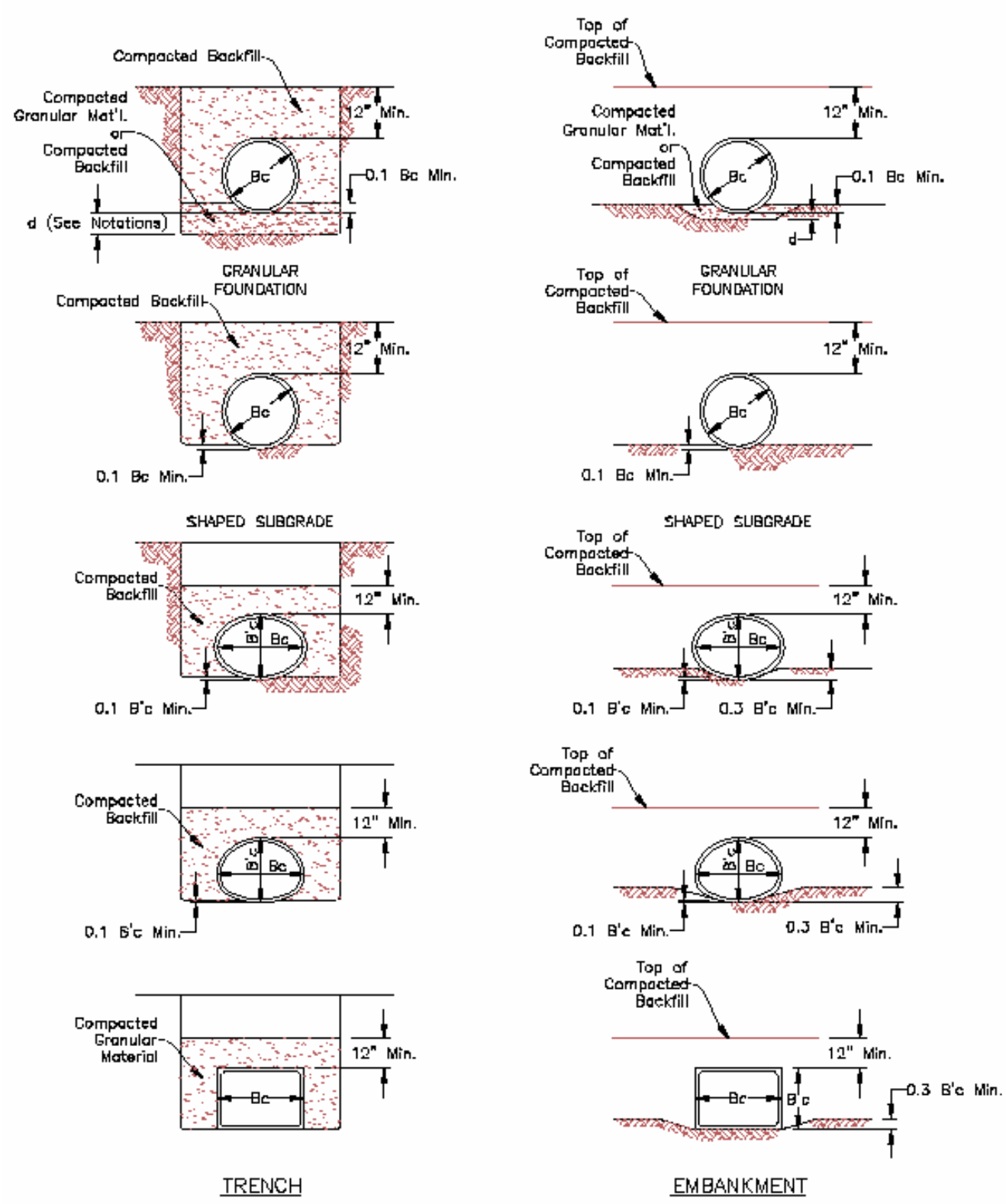


CONCRETE CRADLE TRENCH

CONCRETE CRADLE EMBANKMENT

CLASS A
(Figure 1)


Compacted Backfill
12" Min.
Compacted Granular Mat'l.
Bc
0.5 Bc Min.
d (See Notations)
GRANULAR FOUNDATION
Compacted Backfill
12" Min.
Bc
0.1 Bc Min.
Fine Granular Fill Material (2" Min.)
SHAPED SUBGRADE WITH GRANULAR FOUNDATION
Compacted Granular Material
12" Min.
B'c
Bc
0.1 B'c Min.
Fine Granular Fill Material (2" Min.)
Compacted Granular Material
12" Min.
B'c
Bc
0.1 B'c Min.
Fine Granular Fill Material (2" Min.)
Compacted Granular Material
12" Min.
Bc
Fine Granular Fill Material (2" Min.)
TRENCH
Top of Compacted Backfill
12" Min.
Compacted Granular Mat'l.
Bc
0.5 Bc Min.
d
Top of Compacted Backfill
GRANULAR FOUNDATION
12" Min.
Compacted Soil
Bc
0.3 Bc Min.
0.1 Bc Min.
Fine Granular Fill Material (2" Min.)
SHAPED SUBGRADE WITH GRANULAR FOUNDATION
Top of Compacted Backfill
12" Min.
Compacted Soil
B'c
Bc
0.3 B'c Min.
0.1 B'c Min.
Fine Granular Fill Material (2" Min.)
Top of Compacted Backfill
12" Min.
Compacted Soil
B'c
Bc
0.3 B'c Min.
0.1 B'c Min.
Fine Granular Fill Material (2" Min.)
Top of Compacted Backfill
12" Min.
Compacted Soil
Bc
B'c
0.3 B'c Min.
Fine Granular Fill Material (2" Min.)
EMBANKMENT



CLASS C
(Figure 3)

400.5 BACKFILL.

(1) General. As soon as practical, all portions of the excavation not occupied by the permanent structure shall be backfilled. Backfill material may be obtained from excavation or from other sources. Backfill material shall be free from stones of such size as to interfere with compaction; free from large lumps which will not break down readily under compaction; and free from frozen lumps, wood, or other extraneous material.

Backfill which will not support any portion of the completed roadbed or embankment shall be placed in layers not more than ten (10) inches in depth (loose measurement). Backfill which will support any portion of the roadbed or embankment shall be placed in uniform layers not to exceed eight inches in depth (loose measurement). Each layer of backfill shall be compacted to a density comparable with the adjacent undisturbed soil or as shown on the Plans.

Each layer of backfill material, if dry, shall be wetted uniformly to the moisture content required to obtain a density comparable with the adjacent undisturbed soil or as shown on the Plans and shall be compacted to that density by means of mechanical tamps or rammers. The use of rolling equipment of the type generally used in compacting embankments will be permitted on portions which are accessible to such equipment.

When tamping equipment is furnished which, when proven to the satisfaction of the City, will adequately compact the backfill material to the density required, the eight (8) inch and ten (10) inch lifts (loose measurement) specified above may be increased to lifts not to exceed 12 inches.

Cohesionless materials, such as sand, may be used for general backfilling purposes. Compaction of cohesionless materials shall be done with vibratory equipment, water ponding or a combination thereof.

(2) Bridge Foundations, Retaining Walls, and Culverts. No backfill shall be placed against any structure until the concrete has reached the minimum flexural strength required in Item 421, "Portland Cement Concrete".

The material used for backfilling shall be free of any appreciable amount of gravel or stone particles more than four inches in greatest dimension and shall be of a gradation that permits thorough compaction. The use of rock or gravel mixed with soil will be permitted, provided the percentage of fines is sufficient to fill all voids and insure a uniform and thoroughly compacted mass of proper density.

When the excavation has been made through a hard material resistant to erosion, the City may require the backfill around piers and in front of abutments and wings to be of stone or lean concrete. Unless otherwise provided, such backfill will be measured and paid for as extra work in accordance with Part I, General Provisions – Division I, General Requirements and Covenants.

Embankment which is too close to a structure to permit compaction by the use of the blading and rolling equipment used on adjoining sections of embankment, shall be placed and compacted in

accordance with Section 400.5(1). Mechanical tamps or rammers shall be required when the structure being backfilled could sustain damage from other compacting operations.

Care shall be taken to prevent any wedging action of backfill against the structure, and the slopes bounding the excavation shall be stepped or serrated to prevent such action. Backfill placed around piers shall be deposited uniformly.

(3) Pipe. After the bedding and pipes have been installed as required, the selected backfill materials shall be brought to proper moisture condition, placed along both sides of the pipe equally, in uniform layers not exceeding eight (8) inches in depth (loose measurement), and each lift thoroughly compacted mechanically. Special care shall be taken to secure thorough compaction of the materials placed under the haunches of the pipe and to prevent damage or displacement of the pipe. Filling and/or backfilling shall be continued in this manner to the elevation of the top of the pipe. Backfill above the top of the pipe shall be placed and compacted in accordance with Subarticle 400.5(1). During construction, protection of the pipe shall be in accordance with the pertinent pipe item. Pipe damaged by the Contractor during construction shall be replaced at the Contractor's expense or repaired to the satisfaction of the City.

The City may reject any material containing more than 20 percent by weight of material retained on a three (3) inch sieve, or material excavated in such a manner as to produce large lumps not easily broken down or which cannot be spread in loose layers. In general, material excavated by means of a trenching machine will meet the requirements above, provided large stones are not present.

Where sewers extend beyond the toe of slope of the embankment and the depth of cover provided by backfill to the original ground level is less than the minimum required by the specifications for the type of pipe involved, additional material shall be placed and compacted, as herein specified for backfill outside the limits of the roadbed, until this minimum cover has been provided.

400.6 CEMENT STABILIZED BACKFILL.

When shown on the Plans, the excavation shall be backfilled to the elevations shown with cement stabilized backfill. Unless otherwise shown on the Plans, cement stabilized backfill shall contain aggregate, water and a minimum of seven (7) percent Portland Cement based on the dry weight of the aggregate, in accordance with Test Method Tex-120-E / ASTM D 1633. Aggregate shall be as shown on the Plans or as approved by the City.

Cement stabilized backfill below the top of sewers, manholes, inlets, or other structures shall be placed equally along all sides of the structure so as to prevent strain on or displacement of the structure. Cement stabilized backfill shall be placed in a manner that will completely fill all voids in the trench. Should compaction be required to fill all voids, hand operated tampers may be used.

400.7 MEASUREMENT.

Excavation and backfill will be measured by the cubic yard. Cutting and restoring of pavement will be measured by the square 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, except as may be modified by General Conditions of Contract Documents. If no adjustment of quantities is required, additional measurements or calculations will not be required.

Unless otherwise shown on the Plans, structural excavation for pipe headwalls, inlets, manholes, culvert widening (extensions) 15 feet or less in length, bridge abutments, retaining walls and side road and private entrance pipe culverts will not be measured but shall be considered subsidiary to the various bid items.

For culvert widening (extensive) greater than 15 feet, quantities for structural excavation will be shown on the Plans.

Structural excavation will be measured by the cubic yard computed by the method of average end areas using the following limits to establish templates for measurement:

(1) For all excavation requiring measurement, except that required for the barrels of pipe culverts; for structural plate structures no material outside of vertical planes one (1) foot beyond the edges of the footings and parallel thereto will be included, unless otherwise shown on the Plans. When the Plans provide the Contractor the option of cast-in-place or precast boxes, measurement will be based on the cast-in-place option.

(2) For pipes 42 inches or less in nominal or equivalent diameter, no material outside of vertical planes one foot beyond the horizontal projection of the outside surfaces of the pipe and parallel thereto will be included. For pipes more than 42 inches in nominal or equivalent diameter, no material outside of vertical planes located two (2) feet beyond the horizontal projection of the outside surfaces of the pipe and parallel thereto will be included. Excavation for pipes shall be measured between the extreme ends of the completed structure, including any end appurtenances, as shown on the Plans and from centerline to centerline of inlets, manholes, etc., therein. When excavation for appurtenances is measured for payment, the limits of excavation for the pipes shall not overlap those of the appurtenances.

(3) For structural plate structures no material outside of vertical planes three (3) feet beyond the horizontal projection of the outside surfaces of the structure(s) and parallel thereto will be included. When the quality of the existing soil or embankment is less than that of the proposed backfill material, the excavation shall be extended for measurement to vertical planes located at one-half of the span beyond the horizontal projection of the outside surfaces of the structure(s) and parallel thereto.

(4) If a cofferdam is used, the limitations of Section 400.7(1) shall apply just as if no cofferdam were used. Excavation quantities for foundations shown on the Plans and in the proposal where

cofferdams are required shall be considered as final quantities and no further measurement will be made.

(5) Where excavation, in addition to that allowed for the footings, is required for other portions of the structure, such as for the cap, cross strut, or tie beam of a pier or bent or for the superstructure, measurement for such additional excavation will be limited laterally by vertical planes one (1) foot beyond the face of the member and parallel thereto and vertically to a depth of one (1) foot below the bottom of such member.

(6) No measurement will be made of any excavation necessary for placing forms or falsework except as allowed by the above conditions.

(7) At all structure sites except at culverts and trench excavations, the measurement of structural excavation will include only material below or outside the limits of the completed road or channel excavation.

Trench excavation in fill above natural ground, as specified in Section 400.2(4), will be measured for payment. Quantities will include that area as specified in Section 400.7(2) plus one (1) foot above the top of the pipe, regardless of the height of fill previously made.

(8) Excavation required for shaping the slopes of header banks which were built by prior contract and upon which riprap is to be placed will be measured as "Structural Excavation, (Riprap)".

(9) For all culverts, except for side road and private entrance culverts, all excavation within the limits of the structure and below or outside the limits of the completed roadway excavation, will be measured as culvert excavation. Where the overall normal width of the culvert is 12 feet or less, measurement will be as "Structural Excavation, culvert, Small". Where the overall normal width of the culvert exceeds 12 feet, measurement will be as "Structural Excavation, Culvert, Large".

(10) Where excavation diagrams are shown on the Plans, they shall take precedence over these provisions.

(11) Measurement will not include materials removed below footing grades to compensate for anticipated swelling due to pile driving, nor will it include material required to be removed due to swelling beyond the specified limits during pile driving operations.

(12) Measurement will not include additional volume caused by slips, slides, cave-ins, sitting, or fill material resulting from the action of the elements or the Contractor's operation.

(13) Where rock or other incompressible or unstable material is undercut to provide a suitable foundation for pipe or box sections, such material below grade, which is directed by the City to be removed, will be measured for payment.

(14) No allowance will be made for any variance from plan quantity incurred by an alternate bid.

(15) Additional measurement will be made of the volume of excavation involved in the lowering or raising of the elevation of a footing, foundation, or structure unit, when such grade change is authorized by the City.

(16) Cement stabilized backfill will be measured in accordance with the backfill diagram shown on the Plans. The quantity of "Cement Stabilized Backfill" shown on the Plans shall be considered as final quantities and no further measurement will be required. Changes in alignment or grade as authorized by the City will be measured for payment.

(17) The work to be done in the cutting and restoring of pavement will be measured in accordance with the dimensions shown on the Plans. The excavation below the pavement and/or base shall be measured as structural excavation of the pertinent type.

400.8 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 "Structural Excavation", "Structural Excavation (Bridge)", "Structural Excavation (Culvert, Small)", "Structural Excavation (Culvert, Large)", "Structural Excavation (Trench)", "Structural Excavation (Riprap)", "Cement Stabilized Backfill" and "Cutting and Restoring Pavement".

Payment for removal and replacement of unstable or incompressible material below the footing grades of culverts as provided for in Section 400.2.(3) will be made as follows:

When the Plans specify or when the City directs the use of special materials such as flexible base, cement stabilized base, cement stabilized backfill or other special material, payment for excavation below the footing grades shall be made at the unit price bid for "Structural Excavation" of the pertinent type. Payment for furnishing, hauling, placing and compacting the flexible base, cement stabilized base, cement stabilized backfill or other special materials will be made at the unit price bid for these items in the contract or in accordance with General Requirements and Covenants, in cases where the required material is not a bid item.

Where special materials are not required or specified, payment for the removal and replacement of unstable and/or incompressible material will be made at a price equal to 200 percent of the unit price bid per cubic yard for "Structural Excavation" of the pertinent type. This price shall be full compensation for removing the unstable or incompressible material, furnishing, hauling, placing and compacting suitable replacement material and for all labor, equipment, tools, and incidentals necessary to complete the work.

If no direct method of payment is provided in the contract for culvert excavation and no special materials are required or specified, the removal and replacement of unstable or incompressible material, when such work is authorized by the City, will be measured and paid for at fifteen dollars ($15.00) per cubic yard.

Should the City deem it necessary to lower a bridge foundation to an elevation below the grade shown on the Plans, such over excavation below plan will be paid for as "Structural Excavation" at an adjusted unit price as defined herein. Payment will be made at a unit price equal to 115

percent of the contract unit price bid for all over excavation where the revised footing grade does not vary from plan grade by more than five feet.

Payment will be made at a unit price of 125 percent of the contract unit price bid for all over excavation where the revised grade varies from plan grade by more than five (5) feet but not in excess of ten (10) feet. In cases where the revised footing grade varies from plan grade by more than ten (10) feet, a supplemental agreement shall be prepared to establish a unit price with which to make payment for the over excavation.

No direct payment will be made for backfilling ground structures. Payment for the backfilling and compacting of areas which were removed as structural excavation shall be included in the unit price bid for "Structural Excavation".

Unless otherwise shown on the Plans, structural excavation, which has been completed to the satisfaction of the City, but not backfilled, a partial payment of 50 percent of the price bid, will be made. The remaining amount will be paid upon the satisfactory completion of the backfilling.

This price shall be full compensation for all excavation, bedding, and backfill including placing, sprinkling and compaction of material; all soundings; cleaning and filling seams; constructing all cofferdams; all de-watering; and for furnishing all materials, hauling, labor, equipment, tools, sheeting and/or bracing of excavations up to and including five feet in depth, pumps, drills, explosives, disposition of surplus material, cutting pavement and base to neat lines; and for 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.

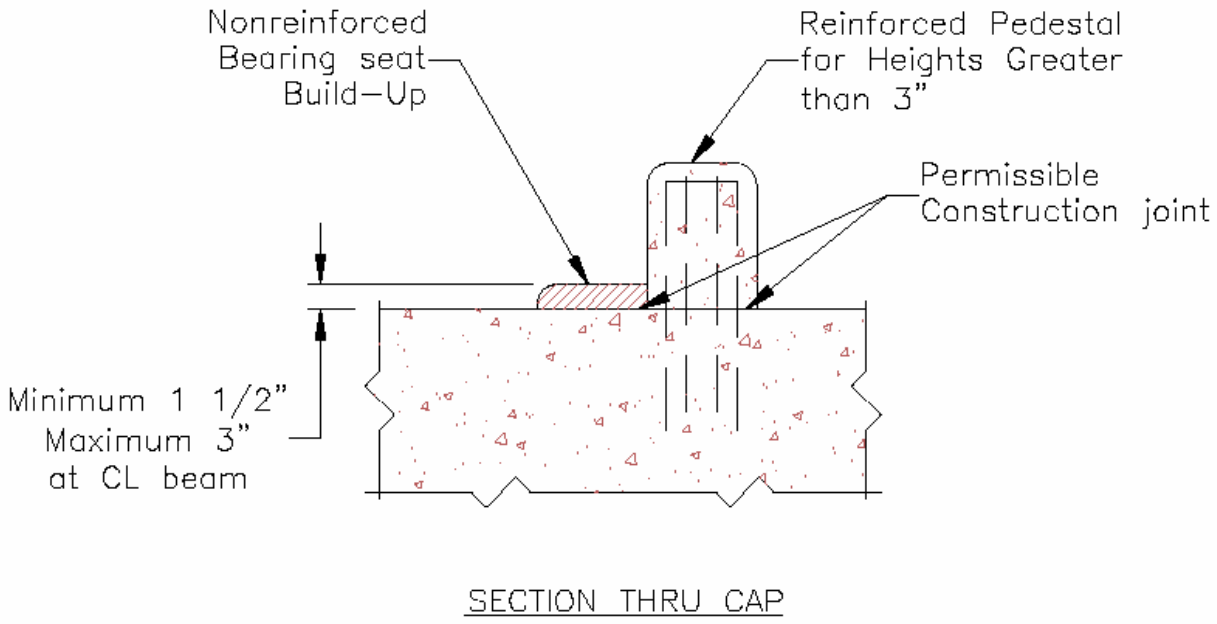
The tops of caps and piers between bearing areas shall be sloped slightly from the center toward the edge, and the tops of abutments and transition bents sloped from the backwall to the edge, as directed by the City, so that the water drains from the surface. The concrete shall be given a smooth trowel 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 421

PORTLAND CEMENT CONCRETE

421.1. DESCRIPTION.

This Item shall govern for Portland Cement Concrete to be used in concrete pavement, concrete structures and other concrete construction.

421.2. MATERIALS.

The concrete shall be composed of Portland Cement, (with or without) fly ash, fine and coarse aggregates and water.

(1) Cement. Portland Cement shall conform to TxDOT Item 524, "Hydraulic Cement".

(2) Mixing Water. Water for use in concrete and for curing shall be free from oils, acids, organic matter or other deleterious substances and shall not contain more than 1000 parts per million of chlorides as CI nor more than 1000 parts per million of sulfates as SO_4.

Water from municipal supplies approved by the State Health Department will not require testing, but water from other sources will be sampled and tested before use in concrete. Tests shall be made in accordance with AASHTO T26.

Water used in white Portland Cement Concrete shall be free from iron and other impurities which may cause staining or discoloration.

(3) Coarse Aggregate. Coarse aggregate shall be washed and shall consist of durable particles of gravel, crushed blast furnace slag, crushed stone, or combinations thereof and shall be free from frozen material or injurious amounts of slat, alkali, vegetable matter, or other objectionable material either free or as an adherent coating. When white Portland cement is specified, the coarse aggregates used in the concrete shall be light colored. Quality shall be reasonably uniform throughout. Coarse aggregate shall not contain more than 0.25 percent by weight of clay lumps, nor more than one (1) percent by weight of shale, nor more than five (5) percent by weight of laminated and/or friable particles when tested in accordance with Test Method Tex-413-A. Coarse aggregate from each source shall have a wear of not more than 40 percent when tested in accordance with Test Method Tex-410-A.

When tested in accordance with Test Method Tex-401-A, the coarse aggregate, including combinations of aggregates when used, shall conform to the gradation requirements shown in Table 1.

TABLE 1
COARSE AGGREGATE GRADATION CHART

Aggregate Grade No.	Nominal Size Inches	Percent Retained on Each Sieve								
		2-1/2 in.	2 in.	1-1/2 in.	1 in.	3/4 in.	1/2 in.	3/8 in.	No. 4	No. 8
1	2	0	0-20	15-50		60-80			95-100	
2	1-1/2		0	0-5		30-65		70-90	95-100	
3	1-1/2		0	0-5		10-40	40-75		95-100	

The loss by decantation in accordance with Test Method Tex-406-A plus the allowable weight of clay lumps, shall not exceed one (1) percent, or the value shown on the Plans, whichever is smaller. In the case of aggregates made primarily from the crushing of stone, if the material finer than the 200 sieve is definitely established to be the dust of fracture, essentially free from clay or shale, as established by Part III of Test Method Tex-406-A, the percent may be increased to 1.5.

(4) Fine Aggregate. Fine aggregate shall be washed and consist of clean, hard, durable and uncoated particles of natural or manufactured sand or a combination thereof, with or without a mineral filler. When white Portland Cement is specified the fine aggregate used in the concrete shall be light colored. It shall be free from frozen material or injurious amounts of salt, alkali, vegetable matter or other objectionable material and it shall not contain more than 0.5 percent by weight of clay lumps. When the aggregate is subjected to the color test for organic impurities in accordance with Test Method Tex-408-A, the test result shall not show a color darker than standard.

Unless otherwise shown on the Plans, the acid insoluble residue of fine aggregate used in concrete subject to direct traffic shall be not less than 60 percent by weight when tested in accordance with Test Method Tex-612-J.

When tested in accordance with Test Method Tex-401-A, the fine aggregate or combinations of aggregates, including mineral filler, shall conform to the gradation requirements shown in Table 2.

TABLE 2
FINE AGGREGATE GRADATION CHART

Aggregate Grade No.	Percent Retained on Each Sieve							
	3/8 in.	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200
1	0	0 to 5	0 to 20	15 to 50	35 to 75	65 to 90	90 to 100	97 to 100

Where manufactured sand is used in lieu of natural sand, the percent retained on the No. 200 sieve shall be 94 to 100.

Where the sand equivalent value is greater than 85, the retainage on the No. 50 sieve may be 65 to 94 percent.

Fine aggregate will be subjected to the Sand Equivalent Test (Test Method Tex-203-F / ASTM D 2419). The sand equivalent shall not be less than 80 unless otherwise shown on the Plans.

For all classes of concrete, the fineness modulus shall be between 2.30 and 3.10 as determined by Test Method Tex-402-A.

(5) Mineral Filler. Mineral filler shall consist of stone dust, clean crushed sand, or other approved inert material. When tested in accordance with Test Method Tex-401-A, it shall conform to the following gradation:

Retained on No. 30 Sieve	0 percent
Retained on No. 200 Sieve	0-35 percent

(6) Admixtures. Admixtures and their use shall conform to the requirements of TxDOT Item 437, "Concrete Admixtures". Calcium chloride will not be permitted.

(7) Mortar and Grout. Unless otherwise specified or approved by the City, mortar and grout shall consist of one part Portland cement, two parts finely graded sand and sufficient water to provide the desired consistency. Mortar may contain admixtures.

Post tensioning grout shall be in accordance with TxDOT Item 426, "Prestressing".

Mortar shall have a consistency such that the mortar can be easily handled and spread by trowel. Grout shall have a consistency such that the grout will flow into and completely fill all voids.

When required to prevent color difference, white cement shall be added to produce the color required. When shown on the Plans or in the specifications, or when required by the City, latex adhesive conforming to the requirements of TxDOT Departmental Material Specification D-9-8110 shall be added to the mortar.

421.3. STORAGE OF MATERIALS.

(1) Cement, and Mineral Filler. All cement and mineral filler shall be stored in well-ventilated weatherproof buildings or approved bi**n**s, which will protect them from dampness or absorption of moisture. Each shipment of packaged cement shall be kept separated to provide easy access for identification and inspection.

(2) Aggregates. The method of handling and storing concrete aggregates shall prevent contamination with foreign materials. If the aggregates are stored on the ground, the sites for the stockpiles shall be clear of all vegetation and shall be level. The bottom six-inch layer of aggregate shall not be disturbed or used without re-cleaning.

(3) Admixtures. Admixtures shall be stored in accordance with TxDOT Item 437, "Concrete Admixtures".

421.4. MEASUREMENT OF MATERIALS.

Except as noted below, the measurement of materials used in batches of concrete shall be by weight.

Water may be measured by volume or by weight.

Cement shall be weighed separately from other materials. Weighing of sacked cement will not be required. When sacked cement is used, the quantity of cement per batch shall be based upon using full bags of cement. Batches involving use of fractional bags will not be permitted except for small hand mixed batches of approximately five (5) cubic feet or less and when an approved method of volumetric measurement is used.

Where two (2) or more sizes or types of aggregates are used, each type and/or size shall be measured separately.

When determining aggregate batch weights, proper allowance shall be made for the water content in the aggregate (free water and/or absorption).

Admixtures shall be measured and dispensed in accordance with TxDOT Item 437, "Concrete Admixtures".

Measuring materials by volumetric methods may be used where permitted by the specifications. When a mixer using volumetric batching of materials is used, an accurate method of measuring by volume shall be provided. Continuous volumetric mixers shall be calibrated to assure correct measurement of materials.

The amount of each ingredient in the batch shall be measured to within plus or minus one percent of required amount except that water shall be measured to within plus or minus one gallon and admixture tolerances shall be in accordance with TxDOT Item 437, "Concrete Admixtures".

421.5. EQUIPMENT.

(1) Weighing and Measuring Equipment. Weighing and measuring equipment shall conform to TxDOT Item 520, "Weighing and Measuring Equipment".

(2) Mixing Equipment.

(a) General. All equipment, tools, and machinery used for hauling materials and performing any part of the work shall be maintained in such condition as to insure completion of the work under way without excessive delays for repairs or replacement.

The mixer shall be of an approved type and size that will produce uniform distribution of the material throughout the mass and shall be capable of producing concrete meeting the requirements of these specifications.

For all mixers, an adequate water supply and an accurate method of measuring the water shall be provided.

Delivery of concrete to the work site and the discharge from the hauling equipment, agitating, or non-agitating, shall be in accordance with the requirements shown on the Plans or in the governing specifications.

Specific requirements for batch plants, mixers and other equipment shall be in accordance with Item 360, "Concrete Pavement", or TxDOT Item 522, "Portland Cement Concrete plants", or other specifications.

421.6. MIXING.

(1) General. Mixed concrete, which does not conform to specification requirements, shall not be placed. Mixing shall be in accordance with TxDOT Item 522, "Portland Cement Concrete plants", except that mixing with continuous volumetric mixers will be in accordance with Section 421.6.(2) and except as set out in Section 421.6.(3).

(2) Continuous Volumetric Mixers. Mixing shall be in accordance with mixer manufacturer's recommendations unless otherwise revised by the City.

(3) Mixing of concrete by hand methods or by the use of a small motor driven mixer will be permitted for small placements of approximately two (2) cubic yards or less when authorized by the City. Hand mixed batches shall not exceed a two-sack batch in volume. For such placements the mix may be proportioned by approved volumetric methods.

421.7. CLASSIFICATION AND MIX DESIGN.

The Contractor shall furnish the mix design, using a coarse aggregate factor acceptable to the City, for the class(s) of concrete specified, to conform with the requirements contained herein and in accordance with Construction Bulletin C-11. The Contractor shall perform, at his entire expense, the work required to substantiate the design. Sampling and testing of concrete will be the responsibility of the City. Complete concrete design data shall be submitted to the City for approval.

The Contractor shall determine and measure the batch quantity of each ingredient, including all water, not only for batch designs but also for all concrete produced for the project. The mixes shall conform to these specifications and other requirements shown on the Plans.

The Contractor may accept a design from the City; however, this acceptance will not relieve the Contractor of the responsibility of providing concrete meeting the requirements of these specifications.

Mix designs from previous or concurrent jobs may be used without trial batches if it is shown that no substantial change in any of the proposed ingredients has been made.

No charge will be made for existing designs furnished by the City. The cost to the City of preparing a new mix design will be charged to the Contractor and deducted from the payment for the work.

Concrete for pneumatically placed concrete shall be in accordance with Item 431, "Pneumatically Placed Concrete".

The Contractor shall have the option of using chemical admixtures with all classes of concrete in accordance with Item 437, "Concrete Admixtures", except where the use of specific admixtures is required or prohibited in this or other items. For example, a mid-range water reducer can help maintain the water/cement ratio below the maximum allowed and provide a better workability to the concrete mix than if a mid-range water reducer was not used.

When a retarding admixture is required for hot weather concreting, the amount to be used will be as required in TxDOT Item 437, "Concrete Admixtures", subject to change by the City when required. When used for extended retardation, the amount to be used will be established by several trial batches with varying retarder content and simulating the placing conditions to be encountered and tested in accordance with Tex-440-A.

When entrained air is required, the concrete shall be designed to entrain five (5) percent air when Grade 1 or 2 coarse aggregate is used, six (6) percent when Grade 3 or 4 coarse aggregate is used, and seven (7) percent for Grades 5,6 or 7 unless otherwise specified by the City. Concrete as placed shall contain the proper amount of entrained air as required herein with a tolerance of plus or minus 1-1/2-percentage points. Acceptance of concrete with occasional variations between 1-1/2 and three (3) percentage points over the specified amount will be based on strength tests as required by the City. When the quantity of entrained air is found to be more than three (3) percentage points over or two (2) percentage points under those values given herein, the concrete will be rejected.

Entrained air will be required for bridge slabs, top slabs of direct traffic culverts, concrete pavement, dense and regular concrete overlays, piers, bents, precast piling (non-prestressed), drilled shafts placed in water, bridge railing, concrete traffic barrier and for other items of work as may be specified, on the Plans or in other specifications.

TABLE 3
SLUMP REQUIREMENTS

Concrete Designation	Desired Slump Inches	Max Slump Inches
A. Structural Concrete		
(1) All drilled shafts	6	7
(2) Thin-Walled Section (9" or less)	4	5
(3) Slabs, Concrete Overlay, Caps, Columns, piers, Wall sections over 9", etc.	3	4
(4) Prestressed Concrete Members	4	5
(5) Concrete traffic Barrier (cast-in-place or precast), Concrete Bridge Railing	4	5
(6) Dense concrete overlay	¾	1
(7) Concrete placed underwater	6	7
(8) Concrete with High Range Water Reducer	-	8
B. Concrete Pavement	1-1/2	3 max 1 min
C. Riprap, curb, gutter, slipformed and extruded concrete	As Approved by the City	

Note: No concrete will be permitted with a slump in excess of the maximums shown. When high-range water reducing admixtures are used, the slump shall not exceed eight (8) inches.

421.8. QUALITY OF CONCRETE.

The concrete shall be uniform, workable and of a consistency acceptable to the City. The cement content, maximum allowable water/cement ratio, the desired and maximum slump, the proper amount of entrained air and the strength requirement for all classes of concrete shall be the responsibility of the Contractor to provide concrete meeting these requirements.

During the progress of the work, a certified testing laboratory technician will cast test cylinders and/or beams, perform slump and entrained air tests and will make temperature checks, as required, to ensure compliance with the specifications.

Unless otherwise shown on the Plans, the Contractor shall furnish and properly maintain all test molds. The test molds shall meet the requirements of Test Methods Tex-418-A / ASTM C 39 and Tex-448-A / ASTM C 78 and, in the opinion of the City, must be satisfactory for use at the time of use. In addition, the Contractor shall be responsible for furnishing personnel to remove the test specimens from the molds and transport them to the proper curing location at the schedule designated by the City and in accordance with the governing specification. For all concrete items

the Contractor shall have a wheelbarrow, or other container acceptable to the City, available to use in the sampling of the concrete.

All labor and equipment furnished by the Contractor will be considered subsidiary to the various bid items and will not be paid for directly.

A strength test is defined as the average of the breaking strength of two (2) cylinders or two (2) beams as the case may be. Each specimen will be tested in accordance with Test Methods Tex-418-A / ASTM C 39 or Tex-448-A / ASTM C 78.

Slump tests will be performed in accordance with Test Method Tex-415-A / ASTM C 143. Entrained air tests will perform in accordance with Test Method Tex-416-A / ASTM C 231.

If the required strength or consistency of the class of concrete being produced cannot be secured with the minimum cement specified or without exceeding the maximum water/cement ratio, the Contractor will be required to furnish different aggregates, use a water reducing agent, an air entraining agent or increase the cement content in order to provide concrete meeting these specifications.

All test specimens, beams or cylinders, representing tests for removal of forms and/or falsework shall be cured using the same methods and under the same conditions as the concrete represented.

"Design Strength" beams and cylinders shall be cast and cured in accordance with Test Method Tex-447-A / ASTM C 31.

When the specified concrete strength is by 28-day compressive strength tests, job control testing will be by 7-day compressive strength tests. The minimum strength requirement for 7-day tests will be 70 percent of the specified minimum 28-day compressive strength. If the required 7-day strength is not obtained with the quantity of cement specified in Table 4, changes in the batch design will be made as specified in this article. For an occasional failure of the 7-day compressive test, the concrete may be tested at 28-days for final evaluation. Strength test requirements for Type II cement will govern when Type I/II cement is used.

TABLE 4

CLASSES OF CONCRETE

Class of Concrete	Cement per C.Y. Min. (sacks)	Min. Comp. Strength 28 day psi	Min. Flexural Strength 7 day psi	Max. Water / Cement Ratio Gal/sk	Coarse Aggregate Grade No.	General Usage (information only)
A	5.0	3,000	425 390 (c)	6.5	1-2- 3-4- 8 (a) (d)	Drilled Shafts; Culverts, except Top Slab of Direct Traffic Culverts; Inlets; Manholes, Headwalls; Approach Slabs; Curb; Gutter, Conc. Retards; Sidewalks; Driveways; Conc. Pavement; Back-up Walls; Anchors
B	4.0	2,000	280	8.0	2-3-4-5-6-7	Riprap, Small Roadside Signs and Anchors
C	6.0	3,600	510 470 (c)	6.0	1-2-3-4-5 (d)	Drilled Shafts; Bridge Substructure; Bridge Railing; Culverts, except Top Slab of Direct Traffic Culverts; Wing Walls; Approach Slab; Concrete Traffic Barrier (cast-in-place)
D	2.0 to 3.0	1,000 to 1,500	215±	11.0±	2-3-4-5-6-7	Riprap Fill Voids Fills
E	6.0	3,000	425	6.0	2-3-4-5	Seal Concrete
S	6.5	4,000	570 525 (c)	5.0	2-3-4-5	Bridge Slab; Top Slab of Direct Traffic Culvert; Bridge Substructure
P	5.0	3,500	555 (b)	6.25	2-3	Concrete Pavement
DC	8.75	5,500	720	3.6	6	Dense Concrete Overlay
CO	7.0	4,600	640	4.5	6	Concrete Overlay

(a) Grade 8 aggregate for use in extruded curbs, unless the City approves a larger size.
(b) Minimum running average for concrete pavement (in accordance with Construction Bulletin C-II).
(c) When Type II or Type I/II cement is used.
(d) Unless otherwise permitted by the City, Grade I coarse aggregate may be used only in massive foundations with four (4) inch minimum clear spacing between reinforcing steel bars. Grade I aggregate may be used in drilled shafts.

421.9. MEASUREMENT AND PAYMENT.

The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the various bid items of the contract.

CITY OF SAN ANGELO

ITEM 433

JOINT SEALANTS AND FILLERS

433.1. DESCRIPTION.

This Item shall govern the material requirements for joint sealants, backing materials and joint fillers.

433.2. MATERIALS.

The materials for this item shall conform to the following:

(1) Joint Sealant Materials. Joint sealant material shall be the class indicated on the Plans or in the governing specifications. The various classes of sealant described herein shall be in accordance with TxDOT Material Specification D-9-6310. Copies of specification D-9-6310 are available from TxDOT, Director of Materials and Tests, 125 E. 11th Street, Austin, TX 78701-2483.

(2) Storage. Class 1 and 2 sealants shall be stored at temperatures between 40ºF and 100ºF. Class 4 and 5 sealants shall be stored in sealed containers at a temperature of 100ºF or below and the material must be used within two (2) months of receipt on the project.

(3) Classes of Joint Sealants.

(a) Class 1. Two Component, Synthetic Polymer, Non-sag. The components shall be proportioned and mixed in accordance with the manufacturer's recommendations.

(b) Class 2. Two Component, Synthetic Polymer, Self-leveling. The components shall be proportioned and mixed in accordance with the manufacturer's recommendations.

(c) Class 3. Hot Poured Rubber. This sealant shall be a rubber asphalt compound which when heated shall melt to the proper consistency for pouring and shall solidify on cooling to ambient temperatures.

(d) Class 4. Non-sag Low Modulus Silicone. The material shall be a single component formulation not requiring addition of a catalyst.

(e) Class 5. Self-leveling Low Modulus Silicone. The material shall be a single component formulation not requiring addition of a catalyst.

(f) Class 6. Preformed Joint Sealant (PJS). The preformed joint sealant shall be an extruded elastomeric material having a multi-channeled shape.

(g) Class 7. Self-leveling, Rapid Curing, Low Modulus Silicone. The material shall be a two component, rapid curing, self-leveling, low modulus formulation. The components shall be proportioned and mixed in accordance with the manufacturer's recommendations.

The size shown on the Plans shall be the nominal width of the sealant. The uncompressed depth of the seal shall be equal to or greater than the width.

All preformed joint sealants installed by the Contractor shall have been pre-qualified for compliance with the requirements. Each size and configuration of seal produced by a manufacturer must be approved by the City prior to use on City of San Angelo projects. For a sealant manufacturer to pre-qualify and obtain approval of a sealant, detailed dimensions and configuration of each size of sealant and certified test results indicating compliance with TxDOT Material Specification D-9-6310 and any requirements shown on the Plans and specifications shall be submitted to the City.

Submission shall be done sufficiently in advance of work to allow for testing and evaluation of the material.

The City will confirm by visual inspection that the sealant proposed for installation is the same size, configuration and manufacture as shown on Plans. The City will examine the sealant for any undue distortions, such as dissymmetry, warping, thick webs or uneven width, which are likely to impair the performance of the joint. If the magnitudes of the distortions are sufficient to create doubt as to the performance of the sealant, the City may direct that the sealant be replaced or that samples representing the worst of the lot be subjected to further testing to verify their performance.

(4) Backer Rods and Backing Materials. These materials shall be capable of holding the fluid sealant in open joints in place. In all cases these materials shall be of such a type that will not bond to the sealant. The backing materials shall meet the requirements of the sealant manufacturer. They shall be compressible type materials, such as closed-cell, resilient foam or sponge rubber stock of vinyl, butyl or neoprene, or expanded polyethylene or polyurethane.

The diameter of the backer rod shall be at least 25 percent larger than the joint reservoir width.

(5) Joint Fillers. Joint fillers shall be of the size, shape and type indicated on the Plans and shall conform to the following requirements.

(a) Timber Boards. Timber boards shall be obtained from redwood, cypress, gum, southern yellow pine or Douglas fir timber. They shall be sound heartwood and shall be free from sapwood, knots, clustered bird's eye, checks and splits. Occasional sound or hollow bird's-eye, when not in clusters, will be permitted provided the board is free from any other defects that will impair its usefulness as a joint filler. All boards, except redwood and cypress, shall have a creosote or pentachlorophenol treatment conforming to TxDOT Item 492 “Timber Preservative and Treatment”, Table 1. When oven dried at 230ºF to a constant weight, the weight of the board per cubic food (minus treatment) shall not be less than 20 pounds or more than 35 pounds.

(b) Asphalt Boards. Asphalt boards shall consist of two (2) suitable asphalt-impregnated liners filled with a mastic mixture of asphalt and vegetable fiber and/or mineral fiber. Asphalt boards shall be smooth, flat and sufficiently rigid to permit installation. When tested in accordance

with Test Method Tex-524-C, the horizontal deflection shall not be more than one inch in 3-1/2 inches.

(c) Preformed Fiber Material.

i. Preformed Bituminous Fiber Material. Preformed bituminous fiber material shall meet the requirements of ASTM D1751.

ii. Preformed Non-bituminous Fiber Material. Preformed non-bituminous fiber material shall meet the requirements of ASTM D1751, except that the requirements pertaining to bitumen content, density and water absorption shall be voided.

(d) Rebonded Neoprene Filler. Rebonded neoprene filler shall consist of ground closed-cell neoprene particles, rebonded and molded into sheets of uniform thickness of the dimensions shown on the Plans, meeting the requirements of ASTM D1752, Type 1. Certification that the material meets these requirements shall be furnished to the City.

433.3. MEASUREMENT.

The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work.

433.4. PAYMENT.

This Item will be paid for by the linear feet as measured in place.

CITY OF SAN ANGELO

ITEM 437

CONCRETE ADMIXTURES

437.1 DESCRIPTION.

This Item shall govern for the admixtures used in Portland Cement Concrete, in accordance with the Plans, specifications and requirements herein.

437.2 MATERIALS.

Admixtures shall be in a liquid state and conform to the following requirements:

Chemical Admixtures – ASTM C494
Air Entraining Admixtures – ASTM C260

437.3 APPROVAL OF ADMIXTURES.

The City reserves the right to perform any or all of the tests required by ASTM C260 and ASTM C494 as a check on the tests reported by the manufacturer. In case of any variance, the City test will govern. Any change in formulation of an admixture shall require retesting, and shall be approved by the City.

A change in formulation discovered by any of the tests prescribed herein, or other means, and not reported and retested, may be just cause to remove a manufacturer from the pre-certified list for City projects.

All documentation and correspondence shall be submitted to the City Engineer, San Angelo, Texas.

437.4 DISPENSING EQUIPMENT.

Each admixture shall be measured and dispensed by a separate readily adjustable dispenser. When set to a predetermined volume, the dispenser shall fill to the preset amount and hold it without leakage until the operator releases the content by some positive means. Unless otherwise shown on the Plans, completely automatic dispensing will not be required, except for use with a fully automatic Plant.

The calibrated container shall be constructed in such a manner that the level of the admixture is visible at all times. A strip gauge with one (1) ounce increments for air-entraining admixtures and ten (10) ounce increments for water reducing and/or retarding admixtures, shall be attached securely to the measuring apparatus. This strip shall be a material possessing weather-resistant qualities. The accuracy required for these systems shall be plus or minus three (3) percent. The equipment shall visibly show the total amount to be dispensed for ready check by the City.

For individual concrete placements of less than two (2) cubic yards at the placement site, the City may waive the requirements for mechanical dispensing equipment.

437.5 CONSTRUCTION USE OF ADMIXTURES.

When used in accordance with the governing specification, the Contractor will be allowed to use any admixture, which has been approved. The Contractor shall submit to the City one (1) copy of the invoice showing the admixture or admixtures to be used on the project. Prior to using an admixture in the work, trial mixes shall be made and tested in the field using the materials and equipment to be used on the project. If more than one (1) admixture is used, they shall be used in such manner that the desirable effects of teach are realized.

Mix designs from previous or concurrent jobs may be used without trial batches if it is shown that no substantial change in any of the proposed ingredients has been made.

The volume of liquid admixtures shall be taken into account when determining the water/cement ratio of the mix.

The dosage rate for air-entraining admixtures shall be adjusted as necessary to produce the required air content in the concrete. The air content shall be in accordance with Item 421, "Portland Cement Concrete", unless otherwise shown on the Plans.

When a retarding admixture is required for extended retardation, the amount to be used shall be established by several trail batches with varying retarder contend and simulating the placing conditions to be encountered. When water reducing or retarding agents are used at the option of the Contractor, reduce dosage of the admixture will be permitted.

Accelerators will be used only to meet special requirements and will require the written approval of the City on each specific project. Accelerating admixtures will not be permitted in bridge decks, top slab of direct traffic culverts, nor when Type II cement is specified.

All accelerating admixtures dosages will be based on trial mixes and approved by the City.

High range water reducers will be used only to meet special requirements and will require written approval of the City on each specific project. A Work Plan for control shall be submitted by the Contractor for approval and an evaluation of the concrete containing the admixture will be performed by the City. Recommended guidelines for developing a Work Plan are shown in TxDOT Construction Bulletin C-11.

Suitable measures shall be taken to prevent admixtures from freezing. Admixtures shall be agitated as required to prevent separation or sedimentation of solids. Air agitation of entraining agents will not be permitted.

Air entraining agents shall be charged into the mixer with the first one-third (1/3) of the mix water. Retarding or water reducing admixtures, except for high-range water reducers, shall be charged into the mixer during the last one-third of the mix water. Each admixture shall be dispensed separately but at the same time as the mixing water. No admixture shall be dispensed on dry aggregates.

Alternate charging sequences based on trial batches may be used subject to approval by the City.

High range water reducing admixtures shall be used and/or dispensed in accordance with the approved Work Plan.

Should the desired effects of an admixture not be achieved in the concrete, the City may take a sample of the admixture being used for further testing. Further use of the admixture will not be allowed until the results of such rest confirm that the admixture has not been changed or altered in any way.

437.6 MEASUREMENT AND PAYMENT.

The work performed, materials furnished and all labor, tools, equipment, and incidentals necessary to complete the work under this Item will not be measured or paid of directly, but will be considered subsidiary to the various bid Item of the contract.

CITY OF SAN ANGELO

ITEM 440

REINFORCING STEEL

440.1. DESCRIPTION.

This Item shall govern for the furnishing and placing of deformed and smooth reinforcing steel, of the sizes and details shown on the Plans and in accordance with this Item. All reinforcing steel to be epoxy coated will be designated on the Plans. Epoxy coating of reinforcing steel shall be in accordance with "Epoxy Coating of Reinforcing Steel" of this Item.

440.2. MATERIALS.

Unless otherwise shown on the Plans or specified herein, the reinforcing steel shall be Grade 60 and all bar reinforcement shall be deformed, conforming to one of the following:

(1) ASTM A615, Grades 40 or 60, open hearth, basic oxygen, or electric furnace new billet steel.

(2) ASTM A617, Grades 40 or 60, axle-steel.

(3) ASTM **A**616, Grade 60, rail steel will be permitted in concrete pavement only. ASTM A616 bars shall be furnished as straight bars only and bending is prohibited. Bend tests will not be required.

(4) ASTM A706, Grade 60, weldable reinforcing steel.

(5) Smooth Bars. Smooth bars for concrete pavement shall have a minimum yield strength of 60 ksi.

All other smooth bars, larger than No. 4, may be steel conforming to the above or may be furnished in any steel that meets the physical requirements of ASTM A36.

(6) Spiral reinforcement shall be either smooth or deformed bars, or wire, of the minimum size or gage shown on the Plans, or as specified herein.

Bars for spiral reinforcement shall comply with ASTM A675, Grade 80 (reference to ASTM A29 is voided) A615 or A617, Grade 40, unless otherwise shown on the Plans. Smooth wire shall comply with ASTM A82 and deformed wire shall comply with ASTM A496.

In cases where the provisions of the Item are in conflict with the provisions of the ASTM Specification, the provisions of this Item shall govern.

Reinforcing steel to be structurally welded shall comply with ASTM A706 or shall have a carbon equivalency (C.E.) of not more than 0.55%. A report of chemical analysis, showing the percentages of all elements necessary to establish the carbon equivalency, will be required for all reinforcing steel that is to be structurally welded. The above requirements do not pertain to miscellaneous welds on reinforcing steel as defined in Item 448, "Structural Field Welding".

Carbon equivalency will be calculated using the following formula:

$$C.E. = \%C + \frac{\%MN}{6} + \frac{\%Cu}{40} + \frac{\%Ni}{20} + \frac{\%Cr}{10} - \frac{\%Mo}{50} - \frac{\%V}{10}$$

The nominal size, area and weight of reinforcing steel bars covered by this specification are as follows:

Bar Size Number	Nominal Diameter In.	Nominal Area Sq. In.	Weight Per Linear Foot
2	0.250	0.05	0.167
3	0.375	0.11	0.376
4	0.500	0.20	0.668
5	0.625	0.31	1.043
6	0.750	0.44	1.502
7	0.875	0.60	2.044
8	1.000	0.79	2.670
9	1.128	1.00	3.400
10	1.270	1.27	4.303
11	1.410	1.56	5.313
14	1.693	2.25	7.65
18	2.257	4.00	13.60

Smooth round bars shall be designated by size number through No. 4. Smooth bars above No. 4 shall be designated by diameter in inches.

(7) Wire for fabric reinforcement shall conform to ASTM A82 or A496. Wire fabric shall conform to ASTM A185 or A497.

When wire is ordered by size numbers, the following relation between size number, diameter in inches and area shall apply unless otherwise specified. Where deformed wire is required, the size number shall be preceded by “D”, and for smooth wire the prefix shall be “W”.

Size Number	Nominal DAMETER IN.	Nominal Area Sq. In.
31	0.628	0.310
30	0.618	0.300
28	0.597	0.280
26	0.575	0.260
24	0.553	0.240
22	0.529	0.220
20	0.505	0.200
18	0.479	0.180
16	0.451	0.160
14	0.422	0.140
12	0.391	0.120
10	0.357	0.100
8	0.319	0.080
7	0.299	0.070
6	0.276	0.060
5.5	0.265	0.055
5	0.252	0.050
4.5	0.239	0.045
4	0.226	0.040
3.5	0.211	0.035
3	0.195	0.030
2.5	0.178	0.025
2	0.160	0.020
1.5	0.138	0.015
1.2	0.124	0.012
1	0.113	0.010
0.5	0.080	0.005

Note: Fractional sizes between the sizes listed above are also available and acceptable for use.

Welded wire fabric will be designated as shown in the following example:

> 6 x 12 - W16 x W8; indicated six (6) inch longitudinal wire spacing and 12 inch transverse wire spacing with smooth Number 16 wire longitudinally and smooth Number 8 wire transversely.

(8) Epoxy Coating. The epoxy coating material and the material used for the repair of the coating shall comply with the TxDOT Departmental Materials Specification D-9-8130, "Epoxy Powder Coating For Reinforcing Steel". Copies of the Departmental Materials Specifications are available from the TxDOT, Division of Materials and Tests, 125 East 11th Street, Austin, Texas 78701-2483. An eight-ounce sample of epoxy powder and manufacturer's certifications will be required for each lot of epoxy powder used to coat materials for City projects.

440.3. BENDING.

The reinforcement shall be bent cold, true to the shapes shown on the Plans. Fabrication shall preferably be done in the shop. Field fabrication, if permitted, shall be done with equipment approved by the City. Misfabricated, damaged or broken bars shall be rejected and replaced at the Contractor's expense. Damaged or broken bars imbedded in a previous concrete placement may be repaired with the approval of the City.

Unless otherwise shown on the Plans, the inside diameter of bar bends, in terms of the nominal bar diameter (d), shall be as follows:

Bends of 90º and greater in stirrups, ties and other secondary bars that enclose another bar in the bend shall be:

#3, #4, #5	4d
#6, #7, #8	6d

All bends in main bars and in secondary bars not covered above shall be:

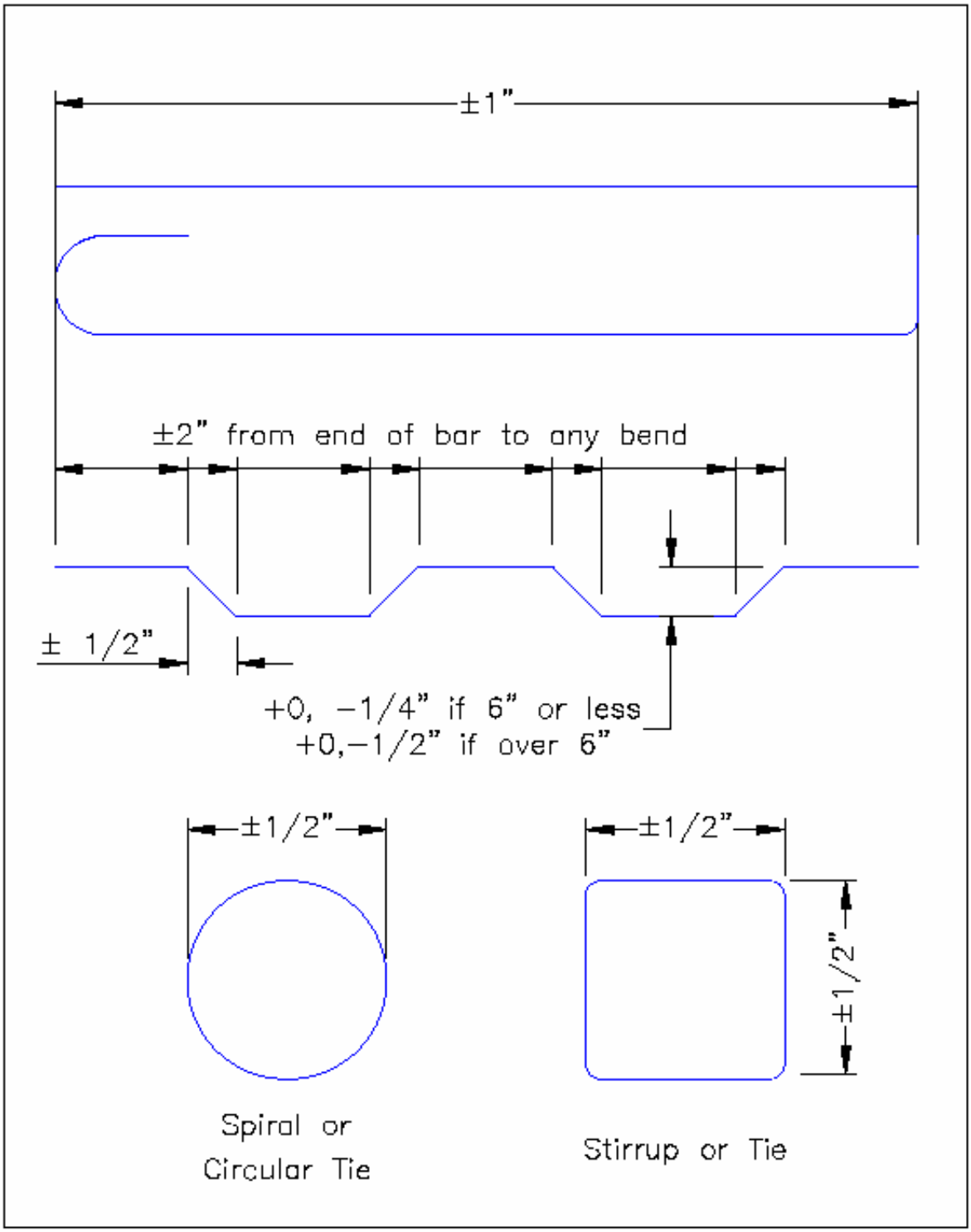
#3 thru #8	6d
#9, #10, #11	8d
#14, #18	10d

Where bending of Grade 60 bars, sizes No. 14 or No. 18 is required, bend testing shall be performed on representative specimens as described for smaller bars in the applicable ASTM Specification. The required bend shall be 90º degrees around a pin having a diameter of ten (10) times the nominal diameter of the bar.

440.4. TOLERANCES

Fabricating tolerances for bars, from Plan dimensions, shall not be greater than shown in Figure 1.

FIGURE 1



440.5. STORING.

Steel reinforcement shall be stored above the surface of the ground upon platforms, skids, or other supports and shall be protected from damage and deterioration as approved by the City. When placed in the work, reinforcement shall be free from dirt, paint, grease, oil, or other foreign materials. Reinforcement shall be free from defects such as cracks and laminations. Rust, surface seams, surface irregularities or mill scales will not be cause for rejection, provided the minimum cross-sectional area of a hand wire brushed specimen meets the requirements for the size of steel specified.

440.6. SPLICES.

Splicing of bars, lap spliced or welded, shall be as shown on the Plans or specified herein. Additional splices will require written approval of the City.

Splices not provided for on the Plans will be permitted in slabs 15 inches or less in thickness, columns, walls and parapets, but will not be included for measurement, subject to the following:

Unless otherwise approved by the City, splices will not be permitted in bars 30 feet or less in Plan length. For bars exceeding 30 feet in Plan length, the distance center to center of splices shall not be less than 30 feet minus one splice length, with no more than one individual bar length less than ten (10) feet. The specified concrete cover and proper spacing shall be maintained at such splices and the lap spliced bars placed in contact and securely tied together.

TABLE 1

MINIMUM LAP REQUIREMENTS FOR BAR SIZES THROUGH NO. 11

SIZE	LAP LENGTH	
	UNCOATED	COATED
No. 3	1’-0”	1’-6”
No. 4	1’6”	2’-3”
No. 5	1’-10”	2’-9”
No. 6	2’-3”	3’-4”
No. 7	3’-0”	4’-6”
No. 8	3’-9”	5’-7”
No. 9	4’-8”	7’-0”
No. 10	5’-7”	8’-4”
No. 11	6’-7”	9’-10”

Spiral steel shall be lapped a minimum of one turn.
Bar sizes No. 14 and No. 18 may not be lapped.

Welded splices shall conform to the requirements of the Plans and TxDOT Item 448, "Structural Field Welding". End preparation for butt welding reinforcing bars shall be done in the field. Delivered bars shall be of sufficient length to permit weld preparation.

Welded wire fabric shall be spliced using a lap length that will include the overlap of a minimum of two (2) cross wires plus two (2) inches on each sheet or roll. Splices using bars, which develop equivalent strength and lapped in accordance with Table 1 will be permitted.

For box culvert extensions with less than one (1) foot of fill, the existing longitudinal bars shall have a lap with the new bars as shown in Table 1. For extensions with more than one (1) foot of fill, a minimum of six-inch lap will be required.

440.6. MECHANICAL COUPLERS.

(1) General. When shown on the Plans, mechanical splices may be made in the reinforcing steel bars using one of the following types:

Sleeve-Filler Type
Sleeve-Threaded Type
Sleeve-Swaged Type
Sleeve-Wedge Type

A pre-qualified manufacturer shall produce all couplers furnished by the Contractor. Pre-qualification shall be in accordance with TxDOT Departmental Material Specification D-9-4510. Sleeve-wedge type couplers will not be permitted on coated reinforcing.

(2) Project Samples. For purposes of sampling couplers for use on an individual project, a lot of couplers shall be defined as 500 couplers, or fraction thereof, for each size and type. Prior to use on the project, three (3) test specimens shall be assembled using couplers selected at random from each lot received on the project. All test specimens shall be assembled from materials consigned to the project and shall be assembled in the presence of the City. A test specimen shall consist of a coupler connecting two (2) 21 inch, or longer, bars using the same splice materials, position, equipment and procedures to be used to make splices in the work. The assembled test specimens shall be submitted to the Division of Materials and Tests for testing. Each lot of couplers shall be identified with tags or markings identifying the lot from which the samples were taken.

(3) Testing. Project samples will be tested to 125% of specified yield strength and for total slip requirements. When a test representing a lot of couplers fails to meet the requirements, four (4) additional couplers from that lot will be tested. If all four (4) tests meet the requirements, the lot will be accepted for use in the work. If any of the four (4) tests fail to meet the requirements, that lot of couplers will be rejected and not used in the work.

(4) Construction Methods. All coupling devices shall be installed in accordance with the manufacturer's recommendations. Protection of threaded male or female connections shall be provided and the threaded connections shall be clean when making the connection. Damaged threads shall not be repaired.

(5) Alternate Equivalent Strength. Alternate equivalent strength arrangements to be accomplished by substituting larger bar sizes, or more bars, will be considered if approved by the City, in writing, prior to the fabrication of the systems.

440.7. PLACING.

Unless otherwise shown on the Plans, dimensions shown for reinforcement are to be the centers of the bars. Reinforcement shall be placed as near as possible in the position shown on the Plans. In the plane of the steel parallel to the nearest surface of concrete, bars shall not vary from Plan placement by more than one-twelfth (1/12) of the spacing between bars. In the Plane of the steel perpendicular to the nearest surface of concrete, bars shall not vary from Plan placement by more than 1/4-inch. Cover of concrete to the nearest surface of steel shall meet the above requirements but shall never be less than one (1) inch.

For bridge slabs, the clear cover tolerance for the top mat of reinforcement shall be -0, + 1/2 inch.

The reinforcement shall be accurately located in the forms, and firmly held in place, before and during concrete placement, by means of bar supports, adequate in strength and number in order to prevent displacement and to keep the steel at the proper distance from the forms. Bars shall be supported by standard bar supports with plastic tips, plastic bar supports approved by the City or precast mortar or concrete blocks when supports are in contact with removable or stay-in-place forms. Bright basic bar supports may be used to support reinforcing steel placed in slap overlays on concrete panels or on existing concrete slabs. Bar supports in contact with soil or subgrade shall be as approved by the City.

For bar supports with plastic tips, the plastic protection shall have a minimum thickness of 3/32 of an inch and extend upward on the wire to a point at least one-half (1/2) inch above the formwork.

All accessories such as tie wires, bar chairs, supports or clips used with epoxy coated reinforcement shall be of steel, fully coated with epoxy or plastic. Plastic supports approved by the City may also be used with epoxy coated reinforcement.

Mortar or concrete blocks shall be cast to uniform dimensions with adequate bearing area. A suitable tie wire shall be provided in each block for anchoring to the steel. The blocks shall be accurately cast to the thickness required in molds approved by the City. The surface placed adjacent to the form shall be a true Plane, free of surface imperfections. The blocks shall be cured by covering with wet burlap or mats for a period of 72 hours. Mortar for blocks shall contain approximately one (1) part Portland Cement to three (3) parts sand. Concrete for blocks shall contain nine (9) sacks of Portland Cement per cubic yard of concrete.

Individual bar supports shall be placed in rows at four (4) foot maximum spacing in each direction. Continuous type bar supports shall be placed at four (4) feet maximum spacing. Continuous bar supports will be required when permanent metal deck forms are used.

Individual bar supports shall be placed in rows at four-foot maximum spacing in each direction. Continuous type bar supports shall be placed at four (4) feet maximum spacing. Continuous bar supports will be required when permanent metal deck forms are used.

The exposure of the ends of longitudinals, stirrups and spacers used to position the reinforcement in concrete pipe and precast box culverts or sewers shall not be cause for rejection.

Reinforcing steel for bridge slabs, top slabs or direct traffic culverts and the top slabs of prestressed box beams shall be tied at all intersections except that where the spacing is less than one (1) foot in each direction, alternate intersections only need to be tied. For reinforcing steel cages for other structural members, the steel shall be tied at a sufficient number of intersections to provide a rigid cage of steel. Mats of wire fabric shall be fastened securely at the ends and edges.

Before concrete placement, all mortar, mud, dirt, etc., shall be cleaned from the reinforcement. Concrete shall not be placed until authorized by the City.

If the reinforcement is not adequately supported or tied to resist settlement, floating upward, overturning of truss bars, or movement in any direction during concrete placement, concrete placement will be halted until corrective measures are taken.

440.8. EPOXY COATING OF REINFORCING STEEL.

(1) General. When shown on the Plans, coating with epoxy of reinforcing bars, plain wire, deformed wire or welded wire fabric to be used as reinforcement for concrete shall conform to the requirements herein.

(2) Surface Preparation. The reinforcing steel shall be free of surface contaminants such as oil, grease or paint when received at the manufacturer's Plant and prior to cleaning and coating. The surface of steel to be coated shall be cleaned by abrasive blast cleaning. All traces of grit and dust from the blast cleaning shall be removed prior to coating. Other methods of cleaning may be submitted to the City for approval.

(3) Application of Coating. The applicator shall notify the City at least 30 days before the date of production. The coating shall be applied as recommended by the manufacturer of the coating material.

The coating shall be applied to the cleaned surface as soon as possible after cleaning and before oxidation of the surface discernible to the unaided eye occurs. The coating shall be a smooth uniform coat and shall have a thickness of from 7 to 12 mils, after curing. The thickness of the coating shall be measured using magnetic thickness testing gages in accordance with Test Method Tex-728-I.

The coating film shall be fully cured. Sufficient checks shall be made to assure that each coated production lot is supplied in a fully cured condition.

(4) Continuity of Coating. The applicator shall check the coating for continuity after curing. The coating shall be free from holes, voids, cracks, contamination and damaged areas discernible to the unaided eye.

For reinforcing bars a 67-1/2 volt D.C. in-line holiday detector, such as Tinker and Rasor Model M-1 or approved equivalent, shall be used to check the coating for holidays. There shall be no more

than two (2) holidays (pinholes not visually discernible) in any linear foot of a coated reinforcing bar.

Holiday checks to determine acceptability of wire or welded wire fabric shall be made at the manufacturer's Plant with a 67-1/2 volt D.C. in-line holiday detector. For wire, there shall not be more than an average of two (2) holidays per linear foot of wire. For welded wire fabric, there shall not be more than an average of four (4) holidays per linear foot of wire in welded wire fabric when the wire spacings are four (4) inches or more, or six (6) holidays per linear foot of wire when the spacings are less than four (4) inches. Uncoated areas at cut ends shall not be counted, nor shall sharp edges (weld spurs) at intersections be counted as holidays. When measuring the number of holidays, at least one-half (1/2) inch of wire must be included on each side of the intersections being checked.

(5) Repair of Coating. Material for repair of the coating shall comply with the requirements in "Epoxy Coating" of this Item. Repairs shall be made in accordance with procedures recommended by the manufacturer of the epoxy coating powder. Areas to be patched shall receive at least the same coating thickness as required for the original coating.

All visible damage to the coating shall be repaired.

Sawed and sheared ends, cuts, breaks and/or other damage shall be repaired promptly before additional oxidation occurs. Areas to be repaired shall be clean and free from surface contaminants. Repairs shall be made in the shop or in the field as required.

The acceptable amount of patched area at the applicator shall not exceed one-quarter (1/4) inch total length in any linear foot.

(6) Sampling and Testing. Sampling and testing of coated reinforcement shall be in accordance with Test Method Tex-739-I.

(7) Identification and Documentation. Identification of all reinforcing shall be maintained throughout the coating and fabrication process and until delivery to the project site.

For all production of coated reinforcing steel to be used on City projects, the manufacturer shall furnish to the City two copies of a written certification that the coated reinforcing steel meets the requirements of this specification and two copies of the manufacturer's control tests.

(8) Handling. All systems for handling coated reinforcement shall have padded contact areas. Bundling bands shall be padded or suitable banding shall be used to prevent damage to the coating. Bundles of coated reinforcement shall be lifted with a strong back, spreader bar, multiple supports, or a platform bridge. The bundled reinforcement shall be transported with care and stored on protective cribbing. The coated reinforcement shall not be dropped or dragged.

(9) Construction Methods. Flame cutting will not be permitted on coated reinforcement. Saw or shear cutting will be permitted with permission of the City. Cut ends shall be coated as specified in "Repair of Coating" of this Item.

Welding or mechanical coupling of coated reinforcing steel will not be permitted except where specifically shown on the Plans. The epoxy coating shall be completely removed a minimum of six (6) inches beyond the weld limits prior to welding and two (2) inches beyond the limits of the coupler prior to assembly. After welding or coupling, the steel shall be cleaned of all oil, grease, moisture, dirt, welding contamination (slag and/or acid residue) and rust to a near white finish. The existing epoxy shall be checked for damage. Any damaged or loose epoxy shall be removed back to sound epoxy coating.

After proper cleaning, the splice area shall be coated with epoxy repair material to a thickness of 7 to 12 mils. A second application of repair material shall be applied to the bar and coupler interfaces to insure complete sealing of the joint.

440.9. MEASUREMENT AND PAYMENT.

Except as specified below, the work performed, materials furnished, and all labor, tools, equipment and incidentals necessary to complete the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the various bid items of the contract.

The quantities of reinforcing steel shown on the Plans are estimates and are for the Contractor's information.

Compensation for adjustment of reinforcing steel quantities will be as follows:

(1) When the reinforcing steel quantity for a complete structure element has been erroneously included in or omitted from the quantities shown on the Plans, the quantity for that element will be added or deducted for payment. A complete structure element will be the smallest portion of a total structure for which a corresponding quantity of concrete is included on the Plans. Additional payment or reduction in payment for quantities revised in this manner will be made accordingly, in accordance with TxDOT Item 4.3.

(2) When the Plan quantity for reinforcing steel for a complete structure element is in error by five (5) percent or more, a recalculation will be made and payment will be increased or reduced accordingly in accordance with contract documents..

(3) When quantities for reinforcing steel are revised by a change in design, the change in quantities will be calculated. Additional payment or reduction in payment for quantities revised in this manner will be made accordingly, in accordance with contract documents.

The party to the contract requesting the adjustment shall present to the other one (1) copy of the description and location, together with calculations of the quantity for the structure element involved. When this quantity is certified correct by the City, it will become the basis for additional or reduced payment.

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.

CITY OF SAN ANGELO

ITEM 531

SIDEWALKS

531.1. DESCRIPTION.

This Item shall govern for Portland Cement Concrete sidewalks constructed on approved subgrade, foundation material or finished surface in accordance with the lines and grades established by the City and in conformance with details shown on the Plans.

531.2. MATERIALS.

All materials shall conform to the pertinent requirements of the following items:

Item 360, "Concrete Pavement"
Item 420, "Concrete Structures"
TxDOT Item 437, "Concrete Admixtures"
Item 421, "Portland Cement Concrete"
Item 440, "Reinforcing Steel"
TxDOT Item 526, "Membrane Curing"

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.

531.3. CONSTRUCTION METHODS.

(1) Conventionally Formed Concrete. Prior to sidewalk 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 lightly immediately before concrete is deposited thereon.

Forms, where needed, shall be of wood or metal, 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 shall be placed in position as shown on the Plans. Care shall be exercised to keep all steel in its proper location during concrete placement.

Sidewalks shall be constructed in sections of the lengths shown on the Plans. Unless otherwise shown on the Plans or approved by the City, no section shall be less than eight (8) feet or more than 40 feet in length. Sections shall be separated by premolded or board joint of the thickness shown on

the Plans and placed vertically and at right angles to the longitudinal axis of the sidewalk. Where the sidewalk abuts a curb or retaining wall, approved expansion material shall be placed along their entire length. Similar expansion material shall be placed around all obstructions protruding through sidewalks. Sidewalks shall be marked at spacing equal to sidewalk width by the use of approved jointing tools. Each day's production will be terminated at an expansion joint.

(2) Extruded or Slipformed Concrete. Concrete shall be placed with 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. 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. Joints shall be constructed at such locations as directed by the City and conforming to the details shown on the Plans.

(3) General. The completed work shall be cured for a period of not less than 72 hours by one of the methods specified in Item 420, "Concrete Structures".

Regardless of the method of construction, hand finishing will be permitted. All exposed surfaces shall be brushed to a smooth and uniform surface.

Wheelchair ramps shall be in conformance with the details shown on the Plans.

531.4. MEASUREMENT.

Sidewalks, including any required wheelchair ramps, will be measured by the linear foot or by the square foot of surface area, complete in place.

531.5. 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 Sidewalks" of the width shown on the Plans. This price shall be full compensation for furnishing all materials required; surface preparation of base; and for all manipulations, labor, tools, equipment, and incidentals necessary to complete the work.

CITY OF SAN ANGELO

ITEM 900

REFLECTORIZED PAVEMENT MARKINGS

900.1 DESCRIPTION.

This Item shall govern for furnishing and placing reflectorized pavement markings of the types, colors, shapes, sizes, widths and thickness shown on the Plans.

900.2 MATERIALS.

(1) Type I Marking Materials. Type I markings are thermoplastic type materials that require heating to elevated temperatures for application. Type I marking materials shall conform to TxDOT Departmental Materials Specification D-9-8220. Each container of Type I marking material shall be clearly marked to indicate the color, weight, type of material, manufacturer's name and the lot/batch number.

(2) Type II Marking Materials. Type II markings are paint type materials that are applied at ambient or slightly elevated temperatures. Type II marking materials shall conform to TxDOT Departmental Materials Specification D-9-8220, YPT-10 and/or WPT-10 and D-9-8290

(3) Source of Supply. All Type I marking materials shall be purchased on the open market.

All glass traffic beads and Type II paint shall be purchased on the open market.

900.3 EQUIPMENT REQUIREMENTS.

Equipment used to place pavement markings shall:

(1) Be maintained in satisfactory operating condition.

(2) Be considered in satisfactory operating condition if it can repeatedly produce a stripe acceptable to the City.

(3) Meet or exceed the material handling at elevated temperatures requirements of the National Fire Underwriters and the Texas Railroad Commission.

(4) Have production capabilities considered satisfactory by the City when used to place markings other than solid or broken lines.

(5) Be capable of producing a center-line and a no-passing barrier line configuration consisting of one (1) broken line with two (2) solid lines at the same time to the alignment and spacing shown on the Plans.

(6) Be capable of placing lines with clean edges and of uniform cross-section. All lines shall have a tolerance of ± 1/8 inch per four (4) inch width.

(7) Have an automatic cut-off device with manual operating capabilities to provide clean, reasonably square marking ends to the satisfaction of the City, and to provide a method of applying broken line in an approximate stripe-to-gap ration of 10 to 30. The length of the stripe shall not be less than 10 feet or more than 10.5 feet. The total length of any stripe-gap cycle shall not be less than 39.5 feet or more than 40.5 feet.

(8) Provide continuous mixing and agitation of the pavement marking material. The use of pans, aprons or similar appliances which the die overruns will not be permitted for longitudinal striping applications.

(9) Apply beads by an automatic bead dispenser attached to the pavement marking equipment in such a manner that the beads are dispensed uniformly and almost instantly upon the marking as the marking is being applied to the road surface. The bead dispenser shall have an automatic cut-off control, synchronized with the cut-off of the pavement marking equipment.

When Type I markings are to be placed, the Contractor shall have a hand-held thermometer on the project. The thermometer shall be capable of measuring the temperature of the pavement marking material to be placed.

900.4 CONSTRUCTION METHODS.

(1) General. When required by the City, the Contractor and the City shall review the sequence of work to be followed and the estimated progress schedule.

Markings may be placed on roadways either free of traffic or open to traffic. On roadways already open to traffic, the markings shall be placed under traffic conditions that exist with a minimum of interference to the operation of the facility. Traffic control shall be as shown on the Plans or as approved by the City in writing. All markings placed under open-traffic conditions shall be protected from traffic damage and disfigurement. On roadways open to traffic, with three (3) lanes of travel in one direction, all markings shall be placed from the outside lanes only unless otherwise approved in writing by the City.

Guides to mark the lateral location of pavement markings shall be established as shown on the Plans or as directed by the City. The Contractor shall establish the pavement marking guides and the City will verify the location of the guides.

Markings shall be placed in proper alignment with the guides. The deviation rate in alignment shall not exceed one (1) inch per 200 feet of roadway. The maximum deviation shall not exceed two (2) inches nor shall any deviation be abrupt.

Markings shall essentially have a uniform cross-section. The density and quality of markings shall be uniform throughout their thickness. The applied markings shall have no more than five (5) percent, by area, of holes or voids and shall be free of blisters.

Markings, in place on the roadway, shall be reflectorized both internally and externally. Glass beads shall be applied to the materials at a uniform rate sufficient to achieve uniform and distinctive retroreflective characteristics when observed in accordance with TxDOT Test Method Tex-828-B or as otherwise shown on the contract Plans.

The Contractor's personnel shall be sufficiently skilled in the work of installing pavement markings.

Markings placed that are not in alignment or sequence, as shown on the Plans or as stated in this specification, shall be removed by the Contractor at the Contractor's expense. Removal shall be in accordance with Item 901, "Eliminating Existing Pavement Markings and Markers", except for measurement and payment. Guides placed on the roadway for alignment purposes shall not establish a permanent marking on the roadway.

Unless otherwise shown on the Plans, pavement markings may be applied by any method that will yield markings meeting the requirements of this specification.

(2) Surface Preparation. New portland cement concrete surfaces shall be cleaned in accordance with TxDOT Item 678, "Pavement Surface Preparation for Markings" to remove curing membrane, dirt, grease, loose and/or flaking existing construction markings and other forms of contamination.

Older portland cement concrete surfaces and asphaltic surfaces that exhibit loose and/or flaking existing markings shall be cleaned in accordance with TxDOT Item 678, "Pavement Surface Preparation for Markings", to remove all loose and flaking markings.

Pavement to which material is being applied shall be completely dry. Pavements shall be considered dry if, on a sunny day after observation for 15 minutes, no condensation occurs on the underside of a one (1) foot square piece of plastic that has been placed on the pavement and weighted on the edges.

(3) Application of Type I Markings. New portland cement concrete surfaces shall be further prepared for Type I markings, after cleaning, by placing a Type II marking as a sealer in accordance with this Item. When placing Type I markings in new locations on asphaltic surfaces three (3) years old or older or any portland cement concrete surfaces, a Type II marking shall be used as a sealer. Unless otherwise shown on the Plans, existing Portland Cement concrete and asphaltic surfaces to be striped will not require Type II markings as a sealer; existing markings may be used as a sealer in lieu of Type II markings. Type II markings shall be placed a minimum of two (2) and a maximum of thirty (30) calendar days in advance of placing Type I markings. Type II markings, which become dirty due to inclement weather or road conditions shall be cleaned by washing, brushing, compressed air or other means approved by the City, prior to application of Type I markings. If washing is used, the surface of Type II markings shall become thoroughly dry before placing Type I markings. Color, location and configuration of Type II markings shall be the same as that of Type I markings.

Type I pavement marking material shall be applied within temperature limits recommended by the material manufacturer. Application of Type I pavement markings shall be done only on

clean, dry pavement having a surface temperature above 50º F. Pavement temperature shall be measured in accordance with TxDOT Test Method Tex-829-B.

When Type I pavement marking application is by spray, and operation ceases for five (5) minutes or more, the spray head shall be flushed by spraying pavement marking material into a pan or similar container until the pavement marking material being sprayed is at the proper temperature for application.

Unless otherwise directed by the City in writing, Type I pavement marking materials shall not be placed on roadways between September 30 and March 1, subject to temperature and moisture limitations specified herein.

Unless otherwise shown on the Plans, Type I marking minimum thickness shall be 0.060 inch (60 mil) for edgeline markings and 0.090 inch (90 mil) for stop-bars, legends, symbols, gore and center-line/no-passing barrier-line markings, when measured in accordance with TxDOT Test Method Tex-854-B. The maximum thickness of all Type I markings shall be 0.180 inch (180 mil).

The thickness of Type I markings at the time of placement will be measured above the Plane formed by the pavement surface. The City will supply a device to measure the thickness of the applied markings. The markings shall be of uniform thickness throughout their lengths and widths.

(4) Application of Type II Markings. The application of Type II marking materials shall be done only on surfaces with a minimum surface temperature of 50ºF.

The application rate for Type II marking material shall be: between 15 and 20 gallons per mile of solid four (4) inch line and between 30 and 40 gallons per mile for solid eight (8) inch line except that, for new surface treatment projects, the application rate shall be between 25 and 30 gallons per mile of solid four (4) inch line and between 40 and 50 gallons per mile for solid eight (8) inch line.

Pavement markings for new surface treatment projects shall be applied in two (2) applications, each approximately one-half the application rate. The first application shall not contain glass beads. The interval between the first and second applications shall be a minimum of one (1) hour.

When, in the case of impending inclement weather, and the City directs the Contractor to apply water-based traffic paint, the markings are damaged by subsequent rain, sleet, hail, etc., the Contractor will be paid for the initial placement and the replacement markings. However, if the Contractor places the markings at his option, the Contractor is responsible for all costs associated with the replacement markings.

900.5 PERFORMANCE PERIOD FOR TYPE I MARKINGS.

Type I pavement markings shall meet all the requirements of this specification for a minimum of 15 calendar days after installation. Pavement markings that fail to meet all the requirements of this specification shall be removed and replaced by the Contractor at the Contractor's expense.

The Contractor shall replace all pavement markings failing the requirements of this specification within 30 calendar days following notification by the City of such failing. All replacement markings shall also meet all requirements of this specification for a minimum of 15 calendar days after installation.

900.6 MEASUREMENT.

This Item will be measured by the linear foot, by each of the various words, symbols or shapes, or by any other unit as shown on the Plans.

Where double stripes are placed, each stripe will be measured separately.

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 contract documents. If no adjustment of quantities is required, additional measurements or calculations will not be required.

Type II pavement markings requiring two (2) applications on new surface treatments will be measured as one (1) marking.

Type II pavement marking materials, when used as a sealer for Type I markings, will be measured as Type II markings.

900.7 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 "Reflectorized Pavement Markings" of the various types, colors, shapes, sizes, widths and thickness (Type I markings only) specified. This price shall be full compensation for furnishing all materials; for application of pavement markings; and for all other labor, tools, equipment and incidentals necessary to complete the work, except as shown below.

Surface preparation, when shown on the Plans, will be subsidiary to this Bid Item.

Final work zone pavement markings (paint and beads) which will be used as a sealer for Type I pavement markings will be paid for under this Item.

When replacement Type II markings are required due to damage to the original markings from rain, sleet, hail, etc., and the original markings were placed at the direction of the City, the Plan quantity requirements under "Measurement" do not apply to the original and replacement markings. The Contractor will be paid for the actual quantity of original and replacement markings at the unit price bid for that item.

CITY OF SAN ANGELO

ITEM 901

ELIMINATING EXISTING PAVEMENT MARKINGS AND MARKERS

901.1 DESCRIPTION.

This Item shall govern for the elimination of existing pavement markings of the various types and sizes, and raised pavement markers as shown on the Plans or as directed, in writing, by the City.

901.2 MATERIALS.

All surface treatment material application rates shall be as directed by the City. Unless otherwise shown on the Plans, surface treatment materials shall conform to the requirements of Item 300, "Asphalts, Oils and Emulsions", and Item 302, "Aggregates For Surface Treatments". Testing of surface treatment materials may be waived by the City. Asphalt and aggregate types and grades shall be as shown on the Plans or as approved in writing by the City.

901.3 CONSTRUCTION METHODS.

Elimination of existing pavement markings and markers shall be accomplished by one (1) or more of the following methods as approved by the City.

(1) Markings on Asphaltic Surfaces.

(a) Placement of a surface treatment a minimum of two (2) feet wide to cover the existing marking.

(b) Placement of a surface treatment, thin overlay or micro-surfacing a minimum of one (1) lane in width in areas where directional changes of traffic are involved or other areas as directed by the City. Construction methods for surface treatments shall conform to Item 316, "Surface Treatments".

(2) Markings on Concrete Surfaces. Removal by an approved burning method.

(3) Markings on Asphaltic or Concrete Surfaces. Removal by water, water-sand blasting techniques, or by any other method(s) proven satisfactory to the City.

(4) Markers on Asphaltic or Concrete Surfaces. Removal by any mechanical method to remove marker and adhesive.

Existing pavement markings and markers on both concrete and asphaltic surfaces shall be removed in such a manner that color and/or texture contrast of the pavement surface will be held to a minimum.

Removal of pavement markings on concrete surfaces by blast cleaning shall be in accordance with TxDOT Item 678, "Pavement Surface Preparation for Markings", except for measurement and payment. Blast cleaning shall be performed in such a manner that damage to the concrete surface is held to a minimum.

When thermoplastic pavement markings or prefabricated pavement markings are encountered, the application of heat may be used to remove the bulk of the marking material prior to blast cleaning. When heat is used, care shall be taken to prevent spalling of concrete surfaces.

A burner may be used for complete removal of pavement markings. Broom removal or light blast cleaning may be used for removal of minor residue.

Damage, such as spalling, shelling, etc. greater than one-quarter (1/4) inch in depth, caused to asphaltic surfaces resulting from the removal of pavement markers shall be repaired by the application of a two (2) foot wide surface.

901.4 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 "Pavement Surface Preparation for Markings" of the various types specified. The price shall be full compensation for all materials, tools, equipment, labor 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 450
Railing

1. DESCRIPTION

Construct railing of concrete, steel, aluminum, or a combination of these materials, including necessary anchorage for the railing on bridges, culverts, walls, or other structures as shown on the plans.

2. MATERIALS

Use materials that conform to requirements of the following Items.

- Item 421, "Hydraulic Cement Concrete,"
- Item 440, "Reinforcement for Concrete,"
- Item 441, "Steel Structures,"
- Item 442, "Metal for Structures,"
- Item 445, "Galvanizing," and
- Item 540, "Metal Beam Guard Fence."

Provide an approved Type III, Class C epoxy or an epoxy of the type and class stated on the plans where epoxy anchors are allowed or required for installing drilled and epoxied rail anchorage reinforcement or rail anchor bolts in accordance with DMS-6100, "Epoxies and Adhesives." Use other materials if shown on the plans. Provide only dual cartridge epoxy systems mixed with a static mixing nozzle supplied by the epoxy adhesive manufacturer and dispensed with a tool supplied by the epoxy adhesive manufacturer. Do not use bulk epoxies. Drill and install anchorage reinforcement or anchor bolts to the embedment depth shown on the plans or the depth the manufacturer recommends, whichever is deeper. No additional payment will be made for providing embedment deeper than shown on the plans. Select an embedment depth capable of developing the yield strength of the steel anchor based on the product literature for the epoxy and steel anchor being used if no resistance or embedment depth is specified on the plans. Use 60 ksi as the yield strength for reinforcing steel.

3. CONSTRUCTION

Construct railing in accordance with details, alignment, and grade designated on the plans. Do not place railing until falsework or formwork, if any, for the span has been released unless otherwise directed. Adhere to the schedule restrictions for Placing Bridge Rails and Opening to Construction Traffic in Item 422, "Concrete Superstructures." Notify the Engineer after completion of the following steps and obtain approval of work before proceeding to the next step: placing rail reinforcement and pre-pour clear cover checks.

Ensure expansion joints in the railing will function properly before placing concrete.

Furnish either steel or aluminum, but not both, for the entire Contract if the plans allow either steel or aluminum options for a particular railing type.

Install epoxy adhesive anchorages in accordance with the manufacturer's instructions including hole size, drilling equipment and method, hole cleaning equipment and method, mixing and dispensing epoxy, and anchor insertion. Do not alter the manufacturer's mixing nozzle or dispenser. Anchorage bars or bolts must be clean and free of grease, oil, or any other foreign material. Demonstrate hole cleaning method to the Engineer for approval and continue the approved process for all anchorage locations. Do not weld to an anchor bar or anchor bolt that is anchored with epoxy adhesive. Do not expose rail to traffic until epoxy adhesive has obtained full cure in accordance with manufacturer's specifications.

3.1. **Metal Railing.**

3.1.1. **General.** Furnish metal beam rail elements in accordance with Item 540, "Metal Beam Guard Fence."

Fabricate and erect metal railing according to the pertinent provisions of Item 441, "Steel Structures," and the requirements of this Item.

Prepare and submit for approval the required shop or erection drawings in accordance with Item 441, "Steel Structures," when the plans require. Show all splice locations and details on the shop or erection drawings. Splice members only as provided on the plans.

Field-weld when required in accordance with Item 448, "Structural Field Welding."

3.1.2. **Fabrication.** Fabricate metal railing and post panels in sections conforming to the details shown on the plans and field-verified lines and grades. Fabricate adjacent sections so they will accurately engage each other in the field. Match-mark each pair of sections so they can be erected in the same position they were fabricated.

Fabricate metal rail elements included as part of the railing system to the dimensions and cross-sections shown on the plans and within a tolerance of 1/4 in. per 10 feet in the straightness of either edge. Joint and connect metal rail elements to the rail posts as shown on the plans, lapping metal rail elements in the direction of traffic in the adjacent lane. Bolts and nuts for metal railing should meet requirements of ASTM A307 and be galvanized in accordance with Item 445, "Galvanizing," unless otherwise shown on the plans.

Fabricate aluminum in accordance with AWS D1.2.

Heat aluminum materials other than castings to a temperature up to 400°F for no more than 30 min. to facilitate bending or straightening.

3.1.3. **Castings.** Provide permanent mold castings of the materials specified that are true to pattern in form and dimensions and of uniform quality and condition. Castings must be free from cracks and defects such as blowholes, porosity, hard-spots, or shrinkage that could affect their suitability for use. Repair minor defects in aluminum castings by an approved inert gas-welding process. Ensure finished castings are free of burrs, fins, discoloration, and mold marks and that they have a uniform appearance and texture.

Produce castings under radiographic control sufficient to establish and verify a product free from harmful internal defects. Heat-treat the entire lot of castings to the specified temper when required.

Permanently mark the heat or lot number on the web or top of the base of all castings. Furnish mill test reports showing the heat or lot number, chemical composition, tensile strength, elongation, and number of pieces for each casting heat or lot. For aluminum castings, a heat or lot should consist of at least 1,000 lb. of trimmed castings when produced from batch type furnaces, or 2,000 lb. when produced from a continuous furnace during a period of no more than 8 consecutive hours. Furnish the entire number of acceptable posts cast from each heat or lot except when a portion is required to complete a project.

3.1.4. **Corrosion Protection.** Galvanize all portions of steel railing after fabrication in accordance with Item 445, "Galvanizing," unless otherwise noted on the plans. Apply appearance coat to galvanized surface in accordance with Item 445, "Galvanizing," when shown on the plans. When painting is specified in place of galvanizing, shop paint steel in accordance with Item 441, "Steel Structures." Repair any damage to galvanized or painted surfaces after erection in accordance with Items 445, "Galvanizing," and Item 446, "Field Cleaning and Painting Steel," respectively.

Before final acceptance, clean surfaces of aluminum and galvanized steel railing not shown to be painted to remove extrusion marks, grease, dirt, and all other surface contaminants.

3.1.5. **Storage**. Store railing materials above the ground on platforms, skids, or other supports, and keep them free from grease, dirt, and contact with dissimilar metals. Avoid scratching, marring, denting, discoloring, or otherwise damaging the railing.

3.2. **Concrete Railing**. Provide concrete portions of railing in accordance with the requirements of Item 420, "Concrete Substructures," and Item 422, "Concrete Superstructures." Construct forms so the railing line and grade can be checked after the concrete has been placed but before initial set. Do not disturb the form alignment during finish floating of the railing tops. Exercise particular care in other construction to avoid disturbing or vibrating the span with the newly placed railing.

Provide precast members conforming to Item 424, "Precast Concrete Structural Members (Fabrication)."

Slipform construction of railing is permitted unless otherwise shown on the plans. Demonstrate slipforming method showing line and grade of concrete surfaces can be consistently obtained and clear cover outside reinforcing steel be maintained at all times. Stop slipforming railing if specified concrete clear cover is not obtained or appearance of rail is off line and grade.

Do not slipform railing with cast-in-place anchor bolts unless noted otherwise.

Provide additional reinforcing as needed to prevent movement of the reinforcement cage. Clear cover and epoxy coating requirements for additional reinforcement are the same as shown for the rail reinforcement. The rail reinforcing cage may be tack welded to the rail anchorage reinforcement provided the rail and anchorage reinforcement are not epoxy coated and weld locations measured along the rail are no closer than 3 ft. Tie all bar intersections if epoxy coated reinforcement is required for the railing proposed to be slipformed. Provide a wire line to maintain vertical and horizontal alignment of the slipform machine. Attach a grade line gauge or pointer to the machine so a continuous comparison can be made between the rail being placed and the established grade line. Rails or supports at the required grade are allowed instead of sensor controls. Make one or more passes with the slipform over the rail segment to ensure proper operation and maintenance of grades and clearances before placing concrete. Provide slipformed rail within a vertical and horizontal alignment tolerance of ±1/4 in. per 10 feet. Construct rail with a smooth and uniform appearance. Consolidate concrete so it is free of honeycomb. Provide concrete with a consistency that will maintain the shape of the rail without support. Minimize starting and stopping of the slipform operation by ensuring a continuous supply of concrete.

Do not exceed the manufacturer's recommended speed for the slipform machine. Stop slipforming and take remedial action if slipforming causes movement of the reinforcement such that plan clearances are not achieved. Remove and replace unsatisfactory slipformed rail at the Contractor's expense.

3.3. **Tests**. The Engineer will sample cast aluminum posts for testing in accordance with Tex-731-I to verify the material requirements of Item 442, "Metal for Structures." Metal beam rail elements may be sampled in accordance with Tex-713-I. The Engineer may sample bolts and nuts in accordance with Tex-708-I for galvanized coating testing.

The Engineer will select 3 anchor bars or bolts from the first day's production to be tested after the epoxy has cured. Test the bars or bolts in the presence of the Engineer in accordance with ASTM E1512, using a restrained test, to evaluate the epoxy adhesive's bond strength. Verify the anchor bars or bolts develop the required pullout resistance on the plans or 75% of the yield strength of the bars or bolts, whichever is less, without a bond failure of the epoxy. The Engineer may require additional tests during production. Perform corrective measures to provide adequate capacity if any of the tests do not meet the required test load. Repair damage from testing.

4. MEASUREMENT

This Item will be measured by the foot.

This is a plans quantity measurement Item. The quantity to be paid for is the quantity shown in the proposal except as 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 “Railing” of the type specified. This price will be full compensation for furnishing, preparing, and placing concrete, expansion joint material, reinforcing steel, structural steel, aluminum, cast steel, pipe, anchor bolts or bars, testing of epoxy anchors, and all other materials required in the finished railing; removal and disposal of salvageable materials; and hardware, paint and painting of metal railing, galvanizing, equipment, labor, tools, and incidentals.

Item 462
Concrete Box Culverts and Drains

1. DESCRIPTION

Furnish, construct, and install concrete box culverts and drains.

2. MATERIALS

2.1. **General.** Furnish materials in accordance with the following.

- Item 420, "Concrete Substructures,"
- Item 421, "Hydraulic Cement Concrete,"
- Item 440, "Reinforcement for Concrete," and
- Item 464, "Reinforced Concrete Pipe."

Provide cast-in-place or precast, formed or machine-made, box culverts, and drains. Use Class S concrete for top slabs of cast-in-place concrete culverts for culverts with overlay, a 1- to 2-course surface treatment or a top slab that is the final riding surface unless otherwise shown on the plans. Use Class C concrete for the rest of the culvert and for all other cast-in-place boxes. Culverts with fill do not require Class S concrete.

Furnish material for machine-made precast boxes in accordance with DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification."

2.2. **Fabrication.**

2.2.1. **Cast-in-Place.** Meet Item 420, "Concrete Substructures" and Item 422, "Concrete Superstructures."

2.2.2. **Formed Precast.** Meet Item 424, "Precast Concrete Structural Members (Fabrication)."

2.2.3. **Machine-Made Precast.** Machine-made precast box culvert fabrication plants must be approved in accordance with DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification." The Department's MPL shows approved machine-made precast box culvert plants. Fabricate machine-made precast boxes in accordance with DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification."

2.3. **Testing.**

2.3.1. **Cast-in-Place.** Provide test specimens that meet Item 421, "Hydraulic Cement Concrete."

2.3.2. **Formed Precast.** Make, cure, and test compressive test specimens in accordance with Tex-704-I.

2.3.3. **Machine-Made Precast.** Make, cure, and test compressive test specimens in accordance with DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification."

2.3.4. **Testing Equipment.** The producer must furnish all equipment required for testing concrete for boxes produced in a precasting plant.

2.4. **Lifting Holes.** Provide no more than 4 lifting holes in each section for precast boxes. Lifting holes may be cast, cut into fresh concrete after form removal, or drilled. Provide lifting holes large enough for adequate

lifting devices based on the size and weight of the box section. Use lifting holes no larger than 3 in. in diameter. Cut no more than 5 in. in any direction of reinforcement per layer for lifting holes.

2.5. **Marking**. Mark precast boxes with the following:

- name or trademark of fabricator and plant location;
- ASTM designation;
- date of manufacture;
- box size;
- minimum and maximum fill heights;
- designated fabricator's approval stamp;
- boxes to be used for jacking and boring (when applicable);
- designation "SR" for boxes meeting sulfate-resistant concrete plan requirements (when applicable); and
- match-marks for proper installation, when required under Section 462.2.6., "Tolerances."

Mark 1 end of each box section, for boxes without lifting holes, on the inside and outside walls to indicate the top or bottom as it will be installed.

Indent markings into the box section or paint them on each box with waterproof paint.

2.6. **Tolerances**. Ensure precast sections meet the permissible variations listed in ASTM C1577 and that the sides of a section at each end do not vary from being perpendicular to the top and bottom by more than 1/2 in. when measured diagonally between opposite interior corners.

Ensure wall and slab thicknesses are not less than shown on the plans except for occasional deficiencies not greater than 3/16 in. or 5%, whichever is greater. If proper jointing is not affected, thicknesses in excess of plan requirements are acceptable.

Deviations from the above tolerances will be acceptable if the sections can be fitted at the plant or jobsite and the joint opening at any point does not exceed 1 in. Use match-marks for proper installation on sections that have been accepted in this manner.

2.6.1. **Boxes for Jacking Operations**. Use boxes for jacking operations as defined in Item 476, "Jacking, Boring, or Tunneling Pipe or Box," meeting the following additional requirements:

- The box ends must be square such that no point deviates more than 3/8 in. from a plane placed on the end of the box that is perpendicular to the box sides, and
- The slab and wall thicknesses must not be less than specified on the plans and must not exceed the specified thickness by more than 1/2 in.

2.7. **Defects and Repair**. Fine cracks on the surface of the member that do not extend to the plane of the nearest reinforcement are acceptable unless the cracks are numerous and extensive. Repair cracks that extend into the plane of the reinforcing steel in an approved manner. Excessive damage, honeycomb, or cracking will be subject to structural review. The Engineer may accept boxes with repairs that are sound, properly finished, and cured in conformance with pertinent specifications. Discontinue further production of precast sections when fine cracks on the surface indicate poor curing practices until corrections are made and proper curing is provided.

Repair machine-made precast boxes in accordance with DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification."

2.8. **Storage and Shipment**. Store precast sections on a level surface. Do not place any load on the sections until design strength is reached and curing is complete. Shipment of sections is permissible when the design strength and curing requirements have been met.

Store and ship machine-made precast boxes in accordance with DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification."

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 shown on the plans or permitted. Jack, bore, or tunnel in accordance with Item 476, "Jacking, Boring, or Tunneling Pipe or Box." Immediate backfilling is permitted for all box structures where joints consist of materials other than mortar. Take precautions in placing and compacting the backfill to avoid any movement of the boxes or damage to the joints. Remove and replace boxes damaged by the Contractor at no expense to the Department.

3.2. **Placement of Boxes**. Place the box sections in conformance with the plans or as directed when precast boxes are used to form multiple barrel structures. Place material to be used between barrels as shown on the plans or as directed. Start the laying of boxes on the bedding at the outlet end and proceed toward the inlet end with the abutting sections properly matched unless otherwise authorized. Fit, match, and lay the boxes to form a smooth, uniform conduit true to the established lines and grades. Lower the box sections into the trench, for trench installations, without damaging the box or disturbing the bedding and the sides of the trench. Carefully clean the ends of the box before it is placed. Prevent the earth or bedding material from entering the box as it is laid. Remove and re-lay, without extra compensation, boxes that are not in alignment or show excessive settlement after laying. Form and place cast-in-place boxes in accordance with Item 420, "Concrete Substructures."

3.3. **Jointing**. Use any of the jointing materials in accordance with the joint requirements specified in Item 464, "Reinforced Concrete Pipe," unless otherwise shown on the plans. Box joints for rubber gasketed material may be substituted for tongue and groove joints, provided they meet the requirements of ASTM C1677 for design of the joints and permissible variations in dimensions.

3.4. **Connections and Stub Ends**. Make connections of boxes to existing boxes, pipes, drains, or 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. Connect boxes to any required headwalls, wingwalls, safety end treatments or riprap, or other structures as shown on the plans or as directed. Repair any damage to the existing structure resulting from making the connections. Finish stub ends for connections to future work not shown on the plans by installing watertight plugs into the free end of the box.

Fill lifting holes with mortar or concrete and cure for precast boxes. Precast concrete or mortar plugs may be used.

3.5. **Extending**. Break back and extend existing culverts in accordance with Section 420.4.8 "Extending Existing Substructures," and Section 422.4.5 "Extending Existing Slabs," as applicable.

4. MEASUREMENT

This Item will be measured by the foot. Measurement will be made between the ends of the culvert or drain along the flow line, not including safety end treatments. Safety end treatments will be measured in accordance with Item 467, "Safety End Treatment." Measurement of spurs, branches, or new connection box section will be made from the intersection of the flow line with the outside surface of the structure into which it connects. Where inlets, headwalls, wingwalls, catch basins, manholes, junction chambers, or other structures are included in lines of culverts or drains, the length of box section tying into the structure wall will be included for measurement, but no other portion of the structure length or width will be included.

The measured length of multiple barrel structures 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 "Concrete Box Culvert" of the size specified. This price is full compensation for constructing, furnishing, and transporting sections; preparation and shaping of the bed; backfill material between box sections; jointing of sections; jointing material; cutting of sections on skew or slope; connections to new or existing structures; breaking back, removing and disposing of portions of the existing structure and replacing portions of the existing structure as required to make connections; concrete and reinforcing steel; and equipment, labor, materials, 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 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 g, 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 466
Headwalls and Wingwalls

1. DESCRIPTION

Furnish, construct, and install concrete headwalls and wingwalls for drainage structures and underpasses.

2. MATERIALS

2.1. **General.** Furnish materials in accordance with the following.

- Item 420, "Concrete Substructures,"
- Item 421, "Hydraulic Cement Concrete," and
- Item 440, "Reinforcement for Concrete."

Use Class C concrete for cast-in-place and precast concrete units unless otherwise shown on the plans. Furnish cast-in-place or precast headwalls and wingwalls unless otherwise shown on the plans.

2.2. **Fabrication.**

2.2.1. **General.** Fabricate cast-in-place concrete units and precast units in accordance with Item 420 "Concrete Substructures." Use the following definitions for headwalls and wingwalls:

- "Headwalls" refers to all walls, including wings, at the ends of single-barrel and multiple-barrel pipe culvert structures.
- "Wingwalls" refers to all walls at the ends of single-barrel or multiple-barrel box culvert structures.

2.2.2. **Lifting Holes.** Provide no more than 4 lifting holes in each section for precast units. Lifting holes may be cast, cut into fresh concrete after form removal, or drilled. Provide lifting holes large enough for adequate lifting devices based on the size and weight of the section. The maximum hole diameter is 3 in. at the inside surface of the wall and 4 in. at the outside surface. Cut no more than 1 longitudinal wire or 2 circumferential wires per layer of reinforcing steel when locating lift holes. Repair spalled areas around lifting holes.

2.2.3. **Marking.** Clearly mark each precast unit before shipment from the casting or fabrication yard with the following:

- the date of manufacture,
- the name or trademark of the manufacturer, and
- the type and size designation.

2.2.4. **Storage and Shipment.** Store precast units on a level surface. Do not place any loads on precast concrete units until design strength is reached. Do not ship units until design strength requirements have been met.

2.2.5. **Causes for Rejection.** Precast units may be rejected for not meeting any one of the specification requirements. Individual units may also be rejected for fractures or cracks passing through the wall or surface defects indicating honeycombed or open texture surfaces. Remove rejected units from the project, and replace them with acceptable units meeting the requirements of this Item.

2.2.6. **Defects and Repairs.** Occasional imperfections in manufacture or accidental damage sustained during handling may be repaired. The repaired units will be acceptable if they conform to the requirements of this Item and the repairs are sound, properly finished, and cured in conformance with pertinent specifications.

3. CONSTRUCTION

3.1. **General**. Remove portions of existing structures and drill, dowel, and grout in accordance with Item 420, "Concrete Substructures."

3.2. **Excavation, Shaping, Bedding, and Backfill**. Excavate, shape, bed, and backfill in accordance with Item 400, "Excavation and Backfill for Structures." Take special precautions in placing and compacting the backfill to avoid any movement or damage to the units. Bed precast units on foundations of firm and stable material accurately shaped to conform to the bases of the units.

3.3. **Placement of Precast Units**. Provide adequate means to lift and place the precast units. Fill lifting holes with mortar or concrete and cure. Precast concrete or mortar plugs may be used.

3.4. **Connections**. Make connections to new or existing structures in accordance with the details shown on the plans. Furnish jointing material in accordance with Item 464, "Reinforced Concrete Pipe," or as shown on the plans.

Remove a length of the existing pipe from the headwall to the joint when removing existing headwalls as shown on the plans or as approved. Re-lay the removed pipe if approved, or furnish and lay a length of new pipe.

4. MEASUREMENT

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.

4.1. **Headwalls**. Headwalls will be measured by each end of a structure.

4.2. **Wingwalls**. Wingwalls will be measured by one of the following methods:

4.2.1. **Square Foot**. Wingwalls will be measured by the square foot of the front surface area of the wall of each type. The area will be measured from the top of the footing or apron to the top of the wall unless otherwise shown on the plans. If there is no footing or apron, then measurement is from the bottom of the wall.

4.2.2. **Each**. Wingwalls will be measured by each end of a structure.

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 price bid for "Headwalls" of the type and pipe size (diameter or design) specified, "Wingwalls" of the type specified when measurement is by the square foot, or "Wingwalls" of the type and wall height specified when measurement is by each. For payment purposes, the wingwall height will be rounded to the nearest foot. All wingwalls and headwalls of the same type will be paid for equally when skew does not affect the type. This price is full compensation for constructing, furnishing, transporting, and installing the headwalls or wingwalls; connecting to existing structure; breaking back, removing and disposing of portions of the existing structure, and replacing portions of the existing structure as required to make connections; excavation and backfill; and concrete, reinforcing steel, corrugated metal pipe or reinforced concrete pipe, equipment, labor, tools, and incidentals.

Apron concrete or riprap between or around the wingwalls of single- or multiple-barrel box culvert structures will be measured and paid for in accordance with Item 432, "Riprap."

The removal and re-laying of existing pipe or the furnishing of new pipe to replace existing pipe will not be paid for directly but will be considered subsidiary to this Item.

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.

Item 560
Mailbox Assemblies

1. DESCRIPTION

Install, remove, temporarily relocate, or replace mailbox assemblies of the type specified.

2. MATERIAL

Furnish mailbox assemblies in accordance with the plans. An assembly does not include the mailbox unless shown otherwise on the plans. Provide new mailbox assemblies for permanent installations.

3. CONSTRUCTION

Temporarily relocate mailbox assemblies as shown on the plans or as directed. Furnish and install approved mailbox assemblies and mount mailboxes on those assemblies. Maintain mailbox assemblies in a serviceable condition. Furnish and install additional mailbox assemblies as directed. Relocate mailbox and assemblies to permanent locations upon completion of construction work.

4. MEASUREMENT

This Item will be measured by each permanent mailbox assembly installed.

5. PAYMENT

The work performed, materials furnished, and measured according to “Measurement” will be paid at the unit price bid for “Mailbox Installation (Single),” of the type specified; “Mailbox Installation (Double),” of the type specified; or “Mailbox Installation (Multiple),” of the type specified. This price is full compensation for installing mailboxes and reflectors in permanent locations, materials, equipment, labor, tools, and incidentals. Removing existing or installing and moving temporary mailbox assemblies will not be paid directly but will be subsidiary to pertinent Items.

Item 585

Ride Quality for Pavement Surfaces

1. DESCRIPTION

Measure and evaluate the ride quality of pavement surfaces.

2. EQUIPMENT

2.1. **Surface Test Type A**. Provide a 10-ft. straightedge or where allowed, a high-speed or lightweight inertial profiler, certified at the Texas A&M Transportation Institute.

2.2. **Surface Test Type B**. Provide a high-speed or lightweight inertial profiler, certified at the Texas A&M Transportation Institute. Provide equipment certification documentation. Display a current decal on the equipment indicating the certification expiration date.

Use a certified profiler operator from the Department's MPL. When requested, furnish documentation for the person certified to operate the profiler.

2.3. **Diamond Grinding Equipment**. Provide self-propelled powered grinding equipment specifically designed to smooth and texture pavements using circular diamond blades when grinding is required. Provide equipment with automatic grade control capable of grinding at least 3 ft. of width longitudinally in each pass without damaging the pavement.

3. WORK METHODS

Measure and evaluate profiles using Surface Test Types A and B on surfaces as described below unless otherwise shown on the plans.

3.1. **Transverse Profile**. Measure the transverse profile of the finished riding surface in accordance with Surface Test Type A.

3.2. **Longitudinal Profile**. Measure the longitudinal profile of the surface, including horizontal curves.

3.2.1. **Travel Lanes**. Unless otherwise shown on the plans, use Surface Test Type B on the final riding surface of all travel lanes except as follows:

3.2.1.1. **Service Roads and Ramps**. Use Surface Test Type A on service roads and ramps unless Surface Test Type B is shown on the plans.

3.2.1.2. **Short Projects**. Use Surface Test Type A when project pavement length is less than 2,500 ft. unless otherwise shown on the plans.

3.2.1.3. **Bridge Structures**. Measure the profile in accordance with the pertinent item or use Surface Test Type A for span type bridge structures, approach slabs, and the 100 ft. leading into and away from such structures.

3.2.1.4. **Leave-Out Sections**. Use Surface Test Type A for leave-out sections and areas between leave-out sections that are less than 100 ft.

3.2.1.5. **Ends**. Use Surface Test Type A on the first and last 100 ft. of the project pavement length.

3.2.2. **Shoulders and Other Areas**. Use Surface Test Type A for shoulders and all other areas including intermediate pavement layers.

3.3. **Profile Measurements**. Measure the finished surface in accordance with Surface Test Type A or B in accordance with Section 585.3.1., "Transverse Profile," Section 585.3.2., "Longitudinal Profile," and the plans.

3.3.1. **Surface Test Type A**. Test the surface with a 10-ft. straightedge as directed. Use an inertial profiler to measure the surface when allowed. The Engineer will use Department software to evaluate the surface.

3.3.2. **Surface Test Type B**.

3.3.2.1. **QC Testing**. Perform QC tests on a daily basis throughout the duration of the project. Use a 10-ft. straightedge, inertial profiler, profilograph, or any other means to perform QC tests.

3.3.2.2. **QA Testing**. Perform QA tests using either a high-speed or lightweight inertial profiler. Coordinate with and obtain authorization from the Engineer before starting QA testing. Perform QA tests on the finished surface of the completed project or at the completion of a major stage of construction, as approved. Perform QA tests within 7 days after receiving authorization.

The Engineer may require QA testing to be performed at times of off-peak traffic flow. Operate the inertial profiler in a manner that does not unduly disrupt traffic flow as directed. When using a lightweight inertial profiler to measure a surface that is open to traffic, use a moving traffic control plan in accordance with Part 6 of the TMUTCD and the plans.

In accordance with Tex-1001-S, operate the inertial profiler and deliver test results within 24 hr. of testing. Provide all profile measurements in electronic data files using the format specified in Tex-1001-S.

3.3.2.2.1. **Verification Testing**. The Engineer may perform ride quality verification testing within 10 working days after the Contractor's QA testing is complete for the project or major stage of construction. When the Department's profiler produces an overall average international roughness index (IRI) value over 3.0 in. per mile higher than the value calculated using Contractor data, the Engineer will decide whether to accept the Contractor's data, use the Department's data, use an average of both parties' data, or request a referee test. Referee testing is mandatory if the difference is greater than 6.0 in. per mile.

3.3.2.2.2. **Referee Testing**. The Construction Division will conduct referee testing, and the results are final. The Construction Division may require recertification for the Contractor's or Department's inertial profiler.

3.4. **Acceptance Plan and Payment Adjustments**. The Engineer will evaluate profiles for determining acceptance, payment adjustment, and corrective action.

3.4.1. **Surface Test Type A**. Use diamond grinding or other approved work methods to correct surface areas that have more than 1/8-in. variation between any 2 contacts on a 10-ft. straightedge. For asphalt concrete pavements, fog seal the aggregate exposed from diamond grinding. Following corrective action, retest the area to verify compliance with this Item.

3.4.2. **Surface Test Type B**. The Engineer will use the QA test results to determine payment adjustments for ride quality using Department software. IRI values will be calculated using the average of both wheel paths. When taking corrective actions to improve a deficient 0.1-mi. section, payment adjustments will be based on the data obtained from reprofiling the corrected area.

3.4.2.1. **IRI Payment Adjustment for 0.1-mi. Sections**. Unless payment adjustment Schedule 1 or 2 is shown on the plans, Schedule 3 from Table 1 and Table 2 will be used to determine the level of payment adjustment for each 0.1-mi. section on the project.

No payment adjustment will be paid for any 0.1-mi. section that contains localized roughness.

3.4.2.2. **IRI Deficient 0.1-mi. Sections**. When payment adjustment Schedule 1 or 2 is specified, correct any 0.1-mi. section with an average IRI over 95.0 in. per mile. Correct the deficient section to an IRI of 65 in. per mile or

less when Schedule 1 is specified or correct to an IRI of 75 in. per mile or less when Schedule 2 is specified. No corrective action is required for Schedule 3. After making corrections, reprofile the pavement section to verify that corrections have produced the required improvements.

The associated payment adjustment shown in Table 1 applies when successful corrective action improves the IRI of a deficient 0.1-mi. section.

If corrective action does not produce the required improvement, the Engineer may require:

- continued corrective action, or
- apply the pertinent payment adjustment shown in Table 2 if the reprofiled IRI is greater than 65 in. per mile.

3.4.2.2.1. **Corrective Action**. Use diamond grinding or other approved work methods to correct any deficient 0.1-mi. section. For asphalt concrete pavements, fog seal the aggregate exposed from diamond grinding or other approved work methods allowed.

3.4.2.3. **Localized Roughness**. Measure localized roughness using an inertial profiler in accordance with Tex-1001-S. The Engineer will determine areas of localized roughness using the individual profile from each wheel path.

Use a 10-ft. straightedge, when allowed, to locate areas that have more than 1/8-in. variation between any 2 contacts on the straightedge when Schedule 3 is specified.

The Engineer may waive localized roughness requirements for deficiencies resulting from manholes or other similar appurtenances near the wheel paths.

3.4.2.3.1. **Corrective Action**. Use diamond grinding or other approved work methods to correct localized roughness. For asphalt concrete pavements, fog seal the aggregate exposed from diamond grinding or other approved work methods allowed. Reprofile the corrected area, and provide results that show the corrective action was successful. If the corrective action is not successful, the Engineer will require continued corrective action or apply a localized roughness payment adjustment.

3.4.2.3.2. **Localized Roughness** Payment Adjustment. Instead of continued corrective action, the Engineer may assess a payment adjustment for each occurrence of localized roughness. No more than one payment adjustment will be applied for any 5 ft. of longitudinal distance. For Schedule 1, a localized roughness payment adjustment of $500 per occurrence will be applied. For Schedule 2, a localized roughness payment adjustment of $250 per occurrence will be applied. For Schedule 3, a localized roughness payment adjustment will not be applied.

Localized roughness payment adjustments will be evaluated within 0.1-mi. sections and applied unless the IRI deficient 0.1-mi. section payment adjustment is greater. When the IRI deficient payment adjustment is greater, the payment adjustment in Table 2 will be applied.

4. MEASUREMENT AND PAYMENT

The work performed, materials furnished, certification and recertification, traffic control for all testing, materials and work needed for corrective action, equipment, labor, tools, and incidentals will not be measured or paid for directly but will be subsidiary to pertinent Items. Sections shorter than 0.1 mi. and longer than 50 ft. will be prorated in accordance with Tex-1001-S.

Table 1
Payment Adjustments for Ride Quality

Average IRI for each 0.10 mi. of Traffic Lane	Payment Adjustment $/0.10 mi. of Traffic Lane	
(in./mi.)	Schedule 1 and Schedule 2	Schedule 3
≤ 30	600	300
31	580	290
32	560	280
33	540	270
34	520	260
35	500	250
36	480	240
37	460	230
38	440	220
39	420	210
40	400	200
41	380	190
42	360	180
43	340	170
44	320	160
45	300	150
46	280	140
47	260	130
48	240	120
49	220	110
50	200	100
51	180	90
52	160	80
53	140	70
54	120	60
55	100	50
56	80	40
57	60	30
58	40	20
59	20	10
60 to 65	0	0

Table 2
Payment Adjustments for Ride Quality

Average IRI for each 0.10 mi. of Traffic Lane	**Payment Adjustment** $/0.10 mi. of Traffic Lane	
(in./mi.)	**Schedule 1**	**Schedule 2**
66	-20	0
67	-40	0
68	-60	0
69	-80	0
70	-100	0
71	-120	0
72	-140	0
73	-160	0
74	-180	0
75	-200	0
76	-220	-20
77	-240	-40
78	-260	-60
79	-280	-80
80	-300	-100
81	-320	-120
82	-340	-140
83	-360	-160
84	-380	-180
85	-400	-200
86	-420	-220
87	-440	-240
88	-460	-260
89	-480	-280
90	-500	-300
91	-520	-320
92	-540	-340
93	-560	-360
94	-580	-380
95	-600	-400
> 95	-3,000	

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.

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

Item 656
Foundations for Traffic Control Devices

1. DESCRIPTION

Construct concrete foundations for small roadside signs, traffic signal controllers, pedestal poles, roadside flashing beacon assemblies, electrical services, and other small traffic control devices.

2. MATERIALS

Ensure materials and construction methods conform to the requirements of this Item and the pertinent requirements of the following Items:

Item 400, “Excavation and Backfill for Structures”
Item 416, “Drilled Shaft Foundations”
Item 420, “Concrete Substructures”
Item 421, “Hydraulic Cement Concrete”
Item 432, “Riprap”
Item 440, “Reinforcement for Concrete”
Item 441, “Steel Structures”
Item 442, “Metal for Structures”
Item 445, “Galvanizing”
Item 447, “Structural Bolting”
Item 449, “Anchor Bolts”
Item 618, “Conduit”

Use Class A concrete for non-reinforced drilled shafts. Use Class C concrete for reinforced drilled shafts. Use Class B concrete or polymer concrete composed of borosilicate glass fiber, catalyzed polyester resin, and aggregate for traffic signal controller foundations. Use drilled shaft or galvanized steel screw-in type foundations for roadside flashing beacon assemblies.

Use reinforcing steel when required.

3. CONSTRUCTION

Stake and install foundations as shown on the plans. The Engineer may shift the foundation locations within design guidelines where necessary to secure a more desirable location or avoid conflict with utilities. Use established industry and utility safety practices when working near underground or overhead utilities. Consult the appropriate utility before beginning work.

Hold anchor bolts in place with templates during concrete placement. Hold embedded items such as conduit or other hardware in place during concrete placement with templates or other approved means. Cap conduits before placing concrete. Ream conduit to remove burrs and sharp edges. Install bell ends or bushings on the conduit.

Carefully align foundation, posts, and anchor bolts. Do not spring or rake posts or anchor bolts.

Remove the top template after concrete has achieved initial set. Keep forms and other bracing intact until the concrete has cured at least one curing day.

Allow concrete for pedestal poles and roadside flashing beacon assemblies to cure at least 7 days before placing bases and poles on the foundation unless otherwise permitted in writing.

Allow concrete for traffic signal controller foundations and small roadside signs to cure at least 4 days before placing cabinets and posts on the foundation unless otherwise permitted.

Provide an ordinary surface finish to the concrete foundation extending above ground in accordance with Section 420.4.13., “Ordinary Surface Finish.”

Place concrete riprap around the foundation in accordance with the plans.

Backfill disturbed surface with material equal in composition and density to the surrounding area. Replace surfacing material with similar material to an equivalent condition.

4. MEASUREMENT AND PAYMENT

The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly but will be subsidiary to pertinent Items.

Item 672
Raised Pavement Markers

1. DESCRIPTION

Furnish and install raised pavement markers (RPMs).

2. MATERIALS

2.1. **Markers.** Furnish RPMs in accordance with the following Department Material Specifications:

Reflectorized Pavement Markers. DMS-4200, "Pavement Markers (Reflectorized)," types I-A, I-C, I-R, II-A-A, and II-C- R.

Traffic Buttons. DMS-4300, "Traffic Buttons," types I-A, I-C, I-R, II-A-A, II-C- R, W, Y and B. Round or oval unless otherwise specified on the plans.

Plowable Reflectorized Pavement Markers. DMS-4210, "Snowplowable Pavement Markers," types I-A, I-C, I-R, II-A-A, and II-C- R.

The following are descriptions for each type of RPM:

Type I-A. The approach face must retro-reflect amber light. The body, other than the retro-reflective face, must be yellow.

Type I-C. The approach face must retro-reflect white light. The body, other than the retro-reflective face, must be white or silver-white.

Type I-R. The trailing face must retro-reflect red light. The body, other than the retro-reflective face, must be white or silver-white, except for I-R plowable markers which may be black.

Type II-A-A. The 2 retro-reflective faces (approach and trailing) must retro-reflect amber light. The body, other than the retro-reflective faces, must be yellow.

Type II-C-R. Contain 2 retro-reflective faces with an approach face that must retro-reflect white light and a trailing face that must retro-reflect red light. The body, other than the retro-reflective faces, must be white or silver-white.

Type W. Must have a white body and no reflective faces.

Type Y. Must have a yellow body and no reflective faces.

Type B. Must have a black body and no reflective faces.

2.2. **Adhesives.** Furnish adhesives that conform to the following requirements:

DMS-6100, "Epoxies and Adhesives," Type II—Traffic Marker Adhesives.

DMS-6130, "Bituminous Adhesive for Pavement Markers."

The Contractor may propose alternate adhesive materials for consideration and approval.

2.3. **Sampling.** The Engineer will sample in accordance with Tex-729-I.

3. CONSTRUCTION

Remove existing RPMs in accordance with Item 677, "Eliminating Existing Pavement Markings and Markers," except for measurement and payment. Furnish RPMs for each class from the same manufacturer. Prepare all surfaces in accordance with Item 678, "Pavement Surface Preparation for Markings," when shown on the

plans. Ensure the bond surfaces are free of dirt, curing compound, grease, oil, moisture, loose or unsound pavement markings, and any other material that would adversely affect the adhesive bond.

Establish pavement marking guides to mark the lateral location of RPMs as shown on the plans and as directed. Do not make permanent marks on the roadway for the guides.

Place RPMs in proper alignment with the guides. Acceptable placement deviations are shown on the plans.

Remove RPMs placed out of alignment or sequence, as shown on the plans or stated in this specification, at Contractor's expense, in accordance with Item 677, "Eliminating Existing Pavement Markings and Markers" (except for measurement and payment).

Use the following adhesive materials for placement of reflectorized pavement markers, and traffic buttons unless otherwise shown on the plans:

standard or flexible bituminous adhesive for applications on bituminous pavements, and

epoxy adhesive or flexible bituminous adhesive for applications on hydraulic cement concrete pavements.

Use epoxy adhesive for plowable reflectorized pavement markers.

Apply enough adhesives to:

ensure that 100% of the bonding area of RPMs is in contact with the adhesive, and

ensure that RPMs, except for plowable markers, are seated on a continuous layer of adhesive and not in contact with the pavement surface.

Apply adhesives in accordance with manufacturer's recommendations unless otherwise required by this Article. Apply bituminous adhesive only when pavement temperature and RPM temperature are 40°F or higher. Do not heat bituminous adhesive above 400°F. Machine agitate bituminous adhesive continuously before application to ensure even heat distribution.

Machine-mix epoxy adhesive. Apply epoxy adhesive only when pavement temperature is 50°F or higher.

Furnish RPMs free of rust, scale, dirt, oil, grease, moisture, and contaminants that might adversely affect the adhesive bond.

Place RPMs immediately after the adhesive is applied and ensure proper bonding. Do not use adhesives or any other material that impairs the functional retro-reflectivity of the RPMs.

Provide a 30-day performance period that begins the day following written acceptance for each separate location. The date of written acceptance will be the last calendar day of each month for the RPMs installed that month for the completed separate project locations. This written acceptance does not constitute final acceptance.

Replace all missing, broken or non-reflective RPMs. Visual evaluations will be used for these determinations. Upon request, the Engineer will allow a Contractor representative to accompany the Engineer on these evaluations.

The Engineer may exclude RPMs from the replacement provisions of the performance, provided the Engineer determines the failure is a result of causes other than defective material or inadequate installation procedures. Examples of outside causes are extreme wear at intersections, damage by snow or ice removal, and pavement failure.

Replace all missing or non-reflective RPMs identified during the performance period within 30 days after notification. The end of the performance period does not relieve the Contractor from the performance deficiencies requiring corrective action identified during the performance period.

4. MEASUREMENT

This Item will be measured by each RPM.

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 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 "Reflectorized Pavement Marker," "Traffic Button," or "Plowable Reflectorized Pavement Marker" of the types specified. This price is full compensation for removing existing markers; furnishing and installing RPMs; and materials, equipment, labor, tools, and incidentals.

No additional payment will be made for replacement of RPMs failing to meet the performance requirements

Item 690
Maintenance of Traffic Signals

1. DESCRIPTION

Furnish, install, modify, repair, replace, or remove components of a traffic signal:

2. MATERIALS

The Department will only furnish traffic signal poles, mast arms, and controllers that become part of the final installation, unless otherwise noted on the plans. Submit a materials list to the Engineer for all poles, mast arms, and controllers needed. Pick up materials at the locations and times shown on the plans. Designate in writing the persons authorized to pick up the materials.

Assume responsibility for all materials furnished by the Department. Use materials furnished by the Department for this Contract only. Return unused or removed materials deemed salvageable by the Engineer to the Department upon completion of the work and before final payment at location shown on the plans or as directed. Dispose of materials deemed unsalvageable by the Engineer, in accordance with federal, state, and local regulations. When materials are required to be furnished by the Contractor, meet the Materials Article requirements of the pertinent Item.

3. EQUIPMENT

Use equipment that includes, but is not limited to:

an aerial device capable of reaching overhead work,
trenching machine,
boring machine,
concrete saw, and
digger-boom truck.

Use only equipment, tools, and machinery in good repair and operating condition. Repair or replace any equipment that, in the opinion of the Engineer, may affect the quality of work or safety.

4. WORK METHODS

Conform to the NEC, local utility requirements, requirements of this Item, and pertinent requirements of the following Items:

Item 416, “Drilled Shaft Foundations,”
Item 421, “Hydraulic Cement Concrete,”
Item 476, “Jacking, Boring, or Tunneling Pipe or Box,”
Item 610, “Roadway Illumination Assemblies,”
Item 618, “Conduit,”
Item 620, “Electrical Conductors,”
Item 622, “Duct Cable,”
Item 624, “Ground Boxes,”
Item 625, “Zinc-Coated Steel Wire Strand,”
Item 627, “Treated Timber Poles,”
Item 628, “Electrical Services,”
Item 636, “Signs,”

Item 656, “Foundations for Traffic Control Devices,”
Item 680, “Highway Traffic Signals,”
Item 682, “Vehicle and Pedestrian Signal Heads,”
Item 684, “Traffic Signal Cables,”
Item 685, “Roadside Flashing Beacon Assemblies,”
Item 686, “Traffic Signal Pole Assemblies (Steel),”
Item 687, “Pedestrian Pole Assemblies,” and
Item 688, “Pedestrian Detectors and Vehicle Loop Detectors.”

Perform the following work as directed:

4.1. **Conduit.** Install, replace, remove, or modify conduits in accordance with Item 618, “Conduit”; as shown on the plans; or as directed. Use 90° “sweep” type elbow on conduits entering a ground box.

4.2. **Foundations.** Install, replace, or remove foundations for traffic signal pole, pedestal pole, and ground mount controller cabinets in accordance with Item 416, “Drilled Shaft Foundations”; and in accordance with Item 656, “Foundations for Traffic Control Devices”; as shown on the plans; or as directed.

4.3. **Concrete.** Install concrete in accordance with Item 421, “Hydraulic Cement Concrete.”

4.4. **Ground Boxes.** Install, repair, replace, remove, or modify ground boxes in accordance with Item 624, “Ground Boxes”; as shown on the plans; or as directed.

4.5. **Vehicle and Pedestrian Detectors.** Install, repair, replace, remove, or modify pedestrian push buttons and vehicle loop detectors in accordance with Item 688, “Pedestrian Detectors and Vehicle Loop Detectors”; as shown on the plans; or as directed.

4.6. **Electrical Service.** Install, repair, replace, remove, or modify an electrical service assembly in accordance with Item 628, “Electrical Services”; as shown on the plans; or as directed. Mount any or all of the following on an electrical service support assembly: conduit, weather head, load center, meter base, lightning protection, wiring, and associated hardware.

4.7. **Signal Pole.** Install, repair, replace, remove, or modify signal poles in accordance with pertinent Items, as shown on the plans, or as directed. Comply with Item 627, “Treated Timber Poles,” for timber signal poles with guy wires and anchors and Item 686, “Traffic Signal Pole Assemblies (Steel),” for steel poles with concrete foundations. Remove timber poles and anchors completely, to 24 in. below ground level, or as directed. Remove concrete foundations to 24 in. below ground level, or as directed.

Install, repair, replace, remove, or modify pedestrian signal pole assemblies in accordance with Item 687, “Pedestrian Pole Assemblies”; as shown on the plans; or as directed. Install, repair, replace, remove, or modify roadside flashing beacons in accordance with Item 685, “Roadside Flashing Beacon Assemblies”; as shown on the plans; or as directed.

4.8. **Down Guy.** Install, replace, remove, or modify down guy with guard or down guy with anchor and guard.

4.9. **Steel Wire Strand.** Install, replace, or remove steel wire strand in accordance with Item 625, “Zinc-Coated Steel Wire Strand”; as shown on the plans; or as directed. Attach span wire on timber poles using a 5/8-in. straight thimble-eye bolt. Attach span wire on metal poles using at least 2 turns of wire around the pole. Place and properly tighten the 3-bolt clamp as near as possible to the pole.

4.10. **Luminaire Head and Mast Arm.** Install, replace, remove, or modify luminaire heads, arms, bulbs, photocells, and hardware on timber or steel signal poles. Install material using manufacturer’s specifications. Fuse luminaires individually in the signal pole hand-hole. Install a separate cable from the breaker load panel to each luminaire.

4.11. **Signal Head Assembly.** Install, repair, replace, remove, or modify pedestrian signal heads or vehicle signal head assemblies in accordance with Item 682, "Vehicle and Pedestrian Signal Heads"; as shown on the plans; or as directed. Mount signal heads by a span wire hanger clamp, bracket arm assembly, or mast arm bracket assembly. Signal head assemblies consist of 1 to 12 signal sections. Install signal heads as shown on the plans, or as directed.

Assemble the signal heads with backplates, louvers, and brackets as needed. Mount all signal heads at the same elevation. Install signal head perpendicular to the travel lane it controls. Plumb all signal heads vertically and horizontally.

4.12. **Traffic Signal Controller Cabinet, Ground Mount.** Install, repair, replace, remove, or modify ground-mounted cabinet. Plumb and tighten the cabinet. Apply silicone sealant around the base of the cabinet. Coil all cabling that enters the cabinet neatly on the cabinet floor. Mark and terminate each cable as shown on the plans, or as directed.

4.13. **Traffic Signal Controller Cabinet, Pole Mount.** Install, repair, replace, remove, or modify pole-mounted cabinet. Plumb and tighten the cabinet. Coil all cabling that enters the cabinet neatly on the cabinet floor. Mark and terminate each cable as shown on the plans, or as directed.

4.14. **Flashing Beacon Controller Cabinet.** Install, repair, replace, remove, or modify flasher cabinet. Plumb and tighten the cabinet. Coil all cabling that enters the cabinet neatly on the cabinet floor. Mark and terminate each cable as shown on the plans, or as directed.

4.15. **Cables.** Install, repair, replace, remove, or modify signal, loop lead-in, electrical, communication, or illumination cables in conduits or along messenger cables in accordance with Item 620, "Electrical Conductors"; in accordance with Item 684, "Traffic Signal Cables"; as shown on the plans; or as directed.

Attach aerial cable at 1-ft. intervals using approved cable ties along a messenger span cable. Install a drip loop with at least 2 turns at each pole, signal head, and weather head.

Label each cable brought into the controller cabinet. Coil 5 ft. of cable neatly on the traffic signal controller cabinet floor for each cable.

Install solderless pressure connectors that meet the requirements of the NEC for all wires attached to terminal posts. Use a ratchet-type full-circle crimper for insulated terminals to provide a solderless pressure connector.

4.16. **Sealing.** Install, repair, replace, remove, or modify sealant in detector saw slots, at the open end of all conduits terminated at the roadway edge, and in ground boxes. Apply sealant as shown on the plans or as directed.

4.17. **Salvage Operations.** Remove traffic signal when no replacement is required. Return unused or removed material deemed salvageable by the Engineer to the Department. Dispose of all other material.

4.18. **Signal-Related Signs.** Install, repair, replace, remove, or modify small post-mounted or overhead signs.

4.19. **Curbs, Ramps, and Sidewalks.** Install, repair, replace, remove, or modify curbs, ramps, and sidewalks. Secure permission to install traffic signal items before cutting into or removing curbs, ramps, and sidewalks. Replace all curbs, ramps, and sidewalks as shown on the plans. Install pedestrian access ramps as shown on the plans.

4.20. **Protection of Utilities.** Locate and protect all public lines and utility customer service lines in the work area. Notify the utility company and locate and mark, uncover, or otherwise protect all such lines in the construction area. Obtain information on the location and grade of water, sewer, gas, telephone, electric

lines, and other utilities in the work area from the utility company. This information does not relieve the Contractor of responsibility for protecting utilities.

Reimburse the utility line owner for expenses or costs (including fines that may be levied against the utility company) that may result from unauthorized or accidental damage to any utility lines in work area.

4.21. **Preservation of Sod, Shrubbery, and Trees.** Preserve all sod, shrubbery, and trees at the site during the Contract. Obtain permission to remove any sod, shrubbery, or tree branches. Preserve and restore sod and shrubbery into their original position. Replace damaged sod or shrubbery at the Contractor's expense.

4.22. **PVC Weatherproof Enclosures.** Install, remove, or replace 12 × 12 × 6-in. PVC weatherproof enclosure at locations shown on the plans or as directed. Only use enclosure for reconnecting or terminating traffic signal cables at the top of a timber or steel strain pole which has been replaced or reinstalled due to accidental knock down.

4.23. **LED Lamp Unit.** Install, replace, or remove LED optical unit in accordance with Item 682, "Vehicle and Pedestrian Signal Heads"; as shown on the plans; or as directed.

4.24. **Spread Spectrum Radio Antennas.** Replace, repair, or install spread spectrum radio antenna in accordance with Special Specification, "Spread Spectrum Radios for Traffic Signals"; as shown on the plan; or as directed.

4.25. **Video Imaging Vehicle Detection System (VIVDS).** Install, repair, replace, remove, or modify VIVDS in accordance with Special Specification, "Video Imaging Vehicle Detection System," as shown on the plans, or as directed.

5. MEASUREMENT

Measurement will be as follows:

5.1. **Removal of Conduit.** By the foot of conduit.

5.2. **Installation of Conduit by Trenching.** By the foot of the trench containing conduit, regardless of the size of conduit.

5.3. **Installation of Conduit by Jacking or Boring.** By the foot of road bore made. Pits for jacking or boring are subsidiary to this Item.

5.4. **Installation of Vehicle Detectors.** By the foot of saw-cut containing detector wire.

5.5. **Removal, Replacement, or Installation of Ground Boxes.** By each box removed, replaced, or installed, regardless of the type of box. A concrete apron around the box will be considered subsidiary to this Item.

5.6. **Removal, Replacement, or Installation of Cables.** By the foot of traffic signal cables removed, replaced, or installed, except measurement will not be made for cable inside signal heads and controllers or cable coiled in ground boxes, in pole bases, and on span wires.

5.7. **Installation of Duct Cables.** By the foot of trench containing duct cable.

5.8. **Removal, Replacement, or Installation of Cables by Messenger Cable.** By the foot removed, replaced, or installed.

5.9. **Removal, Replacement, or Installation of Span Cable Assembly.** By the foot of span removed, replaced, or installed. A span is defined as the distance from one pole to the next pole.

5.10. **Replacement or Installation of Electrical Service.** By each electrical service replaced or installed. The removal of the existing assembly will be considered subsidiary to this Item.

5.11. **Removal, Replacement, or Installation of Timber Poles.** By each timber pole removed, replaced, or installed. Attachment of required hardware is subsidiary to this Item.

5.12. **Removal, Replacement, or Installation of Signal Head Assemblies.** By each head removed, replaced, or installed. Assembly and wiring are subsidiary to this Item.

5.13. **Removal, Replacement, or Installation of Signal Related Signs.** By each sign assembly removed, replaced, or installed.

5.14. **Removal, Replacement, or Installation of Pedestrian Push Buttons.** By each push button removed, replaced, or installed.

5.15. **Removal, Replacement, or Installation of Traffic Signal Pole Foundations.** By the foot, of the type of foundation removed, replaced, or installed.

5.16. **Installation of Foundations for Ground Mount or Pole Mount Cabinets.** By each foundation installed.

5.17. **Removal, Replacement, or Installation of Controller Cabinet, Ground Mount.** By each cabinet removed, replaced, or installed.

5.18. **Removal, Replacement, or Installation of Controller Cabinet, Pole Mount.** By each cabinet removed, replaced, or installed.

5.19. **Removal, Replacement, or Installation of Flasher Cabinet.** By each cabinet removed, replaced, or installed.

5.20. **Installation of Foundations for Roadside Flashing Beacon Assemblies.** By each foundation installed.

5.21. **Removal, Replacement, or Installation of Roadside Flashing Beacon Assemblies.** By each assembly removed, replaced, or installed.

5.22. **Removal, Replacement, or Installation of Signal Pole Assemblies.** By each assembly, according to the type of pole assembly removed, replaced, or installed. Wiring in the pole and hardware is subsidiary to this Item.

5.23. **Removal, Replacement, or Installation of Curbs.** By the foot removed, replaced, or installed.

5.24. **Removal, Replacement, or Installation of Pedestrian Ramps.** By each ramp removed, replaced, or installed.

5.25. **Removal, Replacement, or Installation of Sidewalks.** By the square foot removed, replaced, or installed.

5.26. **Removal of Concrete Foundations.** By each foundation removed.

5.27. **Removal, Replacement, or Installation of Luminaire Heads.** By each luminaire head removed, replaced, or installed.

5.28. **Removal, Replacement, or Installation of Luminaire Mast Arms.** By each mast arm removed, replaced, or installed.

5.29. **Removal, Replacement, or Installation of Down Guy with Guard**. By each down guy with guard removed, replaced, or installed.

5.30. **Removal, Replacement, or Installation of Down Guy with Guard and Anchor**. By each down guy with guard and anchor removed, replaced, or installed.

5.31. **Remove and Salvage Traffic Signals**. By each signalized intersection salvaged. A signalized intersection is a group of traffic signals operated by a single controller.

5.32. **Removal, Replacement, or Installation of 12 × 12 × 6-in. PVC Weatherproof Enclosure**. By each PVC weatherproof enclosure removed, replaced, or installed.

5.33. **Removal, Replacement, or Installation of LED Lamp Unit**. By each LED lamp unit removed, replaced, or installed.

5.34. **Removal, Replacement, or Installation of Spread Spectrum Radio Antennas**. By each radio antenna removed, replaced, or installed.

5.35. **Removal, Replacement, or Installation of Video Imaging Vehicle Detection System (VIVDS)**. By each camera assembly removed, replaced, or installed.

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 prices for the various designations. This price is full compensation for furnishing all materials, equipment, labor, fines, tools, and incidentals. The Department will pay for electrical energy consumed by the traffic signal.

Wiring in the pole; splices; backfill (soil or concrete); sealing of conduit ends and loop detector saw slots; installation of loop wire and PVC for encased loops; protection of utilities; and preservation of sod, shrubbery, and trees will not be measured or paid for directly but will be subsidiary to pertinent Items.

Special Specification 3016
Roller Compacted Concrete

1. DESCRIPTION

Construct roller compacted concrete (RCC) pavement. RCC will provide the final riding surface unless shown on the plans as base course where it will be covered with one or more lifts of asphalt concrete pavement.

This specification references select Sections in Items 360, 420, and 421 of the Texas Department of Transportation's Standard Specifications for Construction and Maintenance for Highways, Streets, and Bridges incorporating current Texas Department of Transportation required special provisions to the Items. Contractor must comply with Item 360, "Concrete Pavement" unless otherwise specified herein.

2. MATERIALS

Furnish materials in accordance with Section 421.2, "Materials" of Item 421, "Hydraulic Cement Concrete" and meet requirements of the following:

2.1. **Aggregate.** Meet the requirements of Section 421.2.6, "Aggregate" except for gradation and additional requirements shown below. For aggregate, use a well-graded aggregate and conforming to one of the combined gradation(s) shown in Table 1.

Table1
RCC Combined Aggregate Gradation

Sieve Size	RCC Surface Course - Percent Passing by Weight	RCC Base/Subbase Course - Percent Passing by Weight
1"	100	100
3/4"	100	90-100
1/2"	70-90	70-90
3/8"	60-85	60-85
#4	40-60	40-60
#16	20-40	20-40
#100	6-18	0-10
#200	0-8	--–

The surface course gradation may be used for a RCC base/subbase course. The base/subbase gradation is not allowed for a surface course mix.

The maximum Plasticity Index (PI) for materials passing the #40 sieve is four (4).

The use of recycled crushed hydraulic cement concrete as a coarse or fine aggregate is allowed. Limit recycled crushed concrete fine aggregate to a maximum of 20% of the fine aggregate.

2.2. **RCC Mix Design.** Design the RCC mix to meet Sections 421.4.2, "Mix Design Proportioning" and 421.4.3, "Concrete Trial Batches" except for the following;

- The requirements of Table 8 in Item 421 do not apply to RCC;
- The requirements of Table 9 along with all requirements for slump, and mix design options in Item 421 do not apply to RCC. The mix shall be stiff enough to support the compaction equipment and while containing adequate cement paste, evenly distributed, to achieve the required strengths.
- The use of Type III cement or accelerators is not allowed unless field demonstrated to allow adequate time for placement and compaction and approved by the Engineer.

- Develop design strength in accordance with the following procedure:

1. Select Aggregates meeting the requirements of Section 2.1,"Aggregate"
2. Select a minimum of three cementitious contents. (Select the cementitious contents such that one content will be at an estimated optimum content, a minimum of one additional content below estimated optimum and a minimum of one above estimated optimum)
3. Determine the optimum moisture content for each cementitious content in accordance with ASTM D 1557, "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort."
4. Cast three samples at optimum moisture content for each cementitious content in accordance with ASTM C 1435, "Standard Practice for Molding Roller-Compacted Concrete in Cylinder Molds Using a Vibrating Hammer."
5. Unless otherwise approved, test all specimens cast for compressive strength in accordance with Tex-418-A at 28 days. Plot the obtained compressive strengths (psi) with their cementitious contents (%). Determine the optimum cementitious content to have a minimum compressive strength of 4,000 psi at 28 days.
6. If the determined optimum cementitious content varies significantly from all cementitious contents used for specimens, determine the optimum moisture content in accordance with ASTM D1557 at the determined optimum cementitious content, recast three specimens in accordance with ASTM C 1435, and test recast specimens with Tex-418-A to verify the compressive strength.

2.3. **Curing Compound**. Provide Type 2 membrane curing compound conforming to DMS 4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants." Provide SS 1 emulsified asphalt conforming to Item 300, "Asphalts, Oils, and Emulsions," for RCC pavement to be overlaid with asphalt concrete under this Contract unless otherwise shown on the plans or approved.

3. EQUIPMENT

Construct roller compacted concrete with any combination of equipment that will produce a completed pavement meeting the requirements for mixing, transporting, placing, compacting, finishing, and curing and in accordance with this specification. Meet the requirements of Section 421.3, "Equipment" except as follows. The mixing equipment will only include the Pugmill and Central-Mixed.

All equipment shall allow for the following requirements to insure quality production.

- Inspection of Equipment. Before start-up, the Contractor's equipment will be carefully inspected. Should any of the equipment fail to operate properly, cease work until the deficiencies are corrected.
- Access for Inspection and Calibration. Provide the Engineer or their representative access at all times for any plant, equipment, or machinery to be used in order to check calibration, scales, controls, or operating adjustments.
- Measurement of Materials. Meet the requirements of 421.4.5, "Measurement of Materials," except that Section 4.4.2, Table 2, "Tolerances for Mixture Ingredients" applies.

3.1. **Mixing Plant.** Locate the mixing plant within a thirty-minute haul time from the point of RCC placement. Use only plants capable of producing an RCC pavement mixture in the proportions defined by the final approved mix design and within the specified tolerances. The capacity of the plant must be sufficient to produce a uniform mixture at a rate compatible with the placement equipment.

If the plant is unable to produce material at a rate adequate to prevent unnecessary cold joints and frequent paver stoppages, the Engineer may halt production until such time that a plant of appropriate capacity is used. Provide and operate plants in accordance with the requirements here and Section 421.4.6, "Mixing and Delivering Concrete."

3.1.1. **Pugmill Plant**. Use only pugmill plants of the central plant type with a twin-shaft mixer, capable of batch or continuous mixing, equipped with synchronized metering devices and feeders to maintain the correct proportions of aggregate, cement, pozzolan, water and chemical admixtures, capable of producing a uniform mixture. Other pugmill plant requirements are as follows:

- Aggregate Storage. If previously blended aggregate is furnished, storage may be in a stockpile from which it is fed directly to a conveyor feeding the mixer. If aggregate is furnished in two size groups, follow proper stockpiling techniques to ensure aggregate separation.
- Aggregate Feed Rate. Use aggregate bins with a feed rate controlled by a variable speed belt, or an operable gate calibrated to accurately deliver any specified quantity of material. If two aggregate size stockpile sources are used, the feed rate from each bin must be readily adjustable to change aggregate proportions, when required. Feed rate controls must maintain the established proportions of aggregate from each stockpile bin when the combined aggregate delivery is increased or decreased.
- Cement and Pozzolan Material Storage. Supply separate and independent storage silos for portland cement and pozzolan.
- Preblended Portland Cement and Pozzolan. If using on-site preblended portland cement and pozzolan (such as fly ash or slag), employ blending equipment acceptable to the Engineer and demonstrate, with a testing plan, the ability to successfully produce a uniform blended material meeting the mix design requirements. Perform testing on at least a daily basis to ensure both uniformity and proper quantities.
- Cement and Pozzolan Feed Unit. Provide a satisfactory means of dispensing portland cement and pozzolan, volumetrically or by weight, to ensure a uniform and accurate quantity of cementitious material enters the mixer.
- Water Control Unit. Use a water control unit capable of measuring the required amount of water for the approved mix by weight or volume. Ensure that the unit is equipped with an accurate metering device. Vary the amount of water to be used only with the approval of the Engineer.
- Gob Hopper. For continuous operating pugmills, provide a gob hopper attached to the end of the final discharge belt to temporarily hold the RCC discharge in order to allow the plant to operate continuously.

3.1.2. **Central Mixed Rotary Drum**. Provide a rotary drum batch mixer capable of producing a homogeneous mixture, uniform in color, and having all coarse aggregate coated with mortar. Equip the mixer with batching equipment to meet the following requirements;

- Weighing Equipment. Measure the amounts of cement, pozzolan, and aggregate entering into each batch of RCC by direct weighing equipment. Use only weighing equipment that is readily adjustable in order to compensate for the moisture content of the aggregate or to change the proportionate batch weights. Include a visible dial or equally suitable device that will accurately register the scale load from zero to full capacity. The cement and pozzolan may be weighed separately or cumulatively in the same hopper on the same scale, provided the cement is weighed first.
- Weigh Hoppers. Use only bulk cement and pozzolan weigh hoppers that are equipped with vibrators to operate automatically and continuously while weighing hoppers are being dumped. Ensure that the weigh hopper has sufficient capacity to hold not less than 10 percent in excess of the cementitious material required for one batch.
- Water Metering. Measure the amount of water entering each batch of RCC by weight or volume. Use only equipment capable of measuring the water to within a tolerance of plus or minus one percent and equipped with an accurate gauge or dial measuring device. Vary the amount of water to be used only with the approval of the Engineer. During batching, admit water to the mixer only through the water measuring device and then only at the time of charging.
- Mixing Time. Use only drum mixers equipped with an accurate clock or timing device, capable of being locked, for visibly indicating the time of mixing after all the materials, including the water, are in the mixer.

- Recharging. Discharge all material in the drum before recharging. Ensure that the volume of mixed material per batch does not exceed the manufacturer's rated capacity of the mixer.

3.1.3. **Alternate Plants.** Obtain approval from the Engineer to use other type plants. Demonstrate that the mixing equipment has the ability to produce a consistent, well-blended, non-segregated RCC mix meeting capacity requirements and tolerances of this specification. Meet the requirements of Section 421.4.6, "Mixing and Delivering Concrete."

3.2. **Paver.** Place RCC with an asphalt-type paver manufactured with a high-density screed subject to approval by the Engineer. Use only pavers equipped with compacting devices capable of producing an RCC pavement with a minimum of 90 percent of the maximum density in accordance with Tex-451-A (ASTM C 1040, "Standard Test Methods for In-Place Density of Unhardened and Hardened Concrete, including Roller Compacted Concrete, By Nuclear Methods") prior to any additional compaction. Ensure that the paver is of suitable weight and stability to spread and finish the RCC material, without segregation, to the required thickness, smoothness, surface texture, cross-section, and grade.

3.3. **Compactors**. Use self-propelled steel drum vibratory rollers having a minimum static weight of 10 tons for primary compaction. For final compaction, use either a steel drum roller, operated in a static mode, or a rubber-tired (pneumatic) roller of equal or greater weight. Use walk-behind vibratory rollers or plate tampers for compacting areas inaccessible to large rollers.

3.4. **Haul Trucks.** Use trucks for hauling the RCC material from the plant to the paver fitted and equipped with retractable protective covers for protection from inclement weather or excessive evaporation. To ensure adequate and continuous supply of RCC material to the paver, have a sufficient number of trucks. If the number of trucks is inadequate to prevent frequent starts and stops of the paver, cease production until additional trucks are obtained.

3.5. **Water Trucks.** Keep at least one water truck, or other similar equipment, on-site and available for use throughout the paving and curing process. Equip such equipment with a spreader pipe containing fog spray nozzles capable of evenly applying a fine spray of water to the surface of the RCC without damaging the final surface.

4. CONSTRUCTION REQUIREMENTS.

4.1. **Submittals for Proposed RCC Mix Design and Paving/Jointing Plan**

4.1.1. **Proposed RCC Mix Design.** Submit a proposed mix design to the Engineer for review. If accepted by the Engineer, prepare and test a trial batch mixture at the Contractor's facilities to verify that the design criteria for strength are met in accordance with 421.4.3, "Concrete Trial Batches." Perform batch mixture preparation and testing in the presence of representatives of the Engineer. Make no production until the mix design has been reviewed and the Engineer has given authorization to proceed.

4.1.2. **Proposed Paving/Jointing Plan.** Submit a paving plan that includes paving sequence, hand pour areas, locations of cold joints, transverse contraction joints, and joints at structures. Use following guides when develop the Paving/Jointing Plan.

- Avoid odd-shaped RCC slabs
- Avoid joint intersection angles less than 60°
- Space transverse contraction joints at 20 ft. spacing
- Saw cut the transverse contraction joint through the curb when RCC has curb.
- Appropriately make field adjustment for joint locations to meet the inlets and manholes

4.2. **Storage of Materials.** Meet the requirements of 421.2.8, "Storage of Materials."

4.3. **Sampling and Testing of Concrete.** Unless otherwise specified, all fresh and hardened concrete is subject to testing as follows:

4.3.1. **Sampling Fresh Concrete.** Provide all material to be tested. Fresh concrete will be sampled for testing at the discharge end if using belt conveyors or pumps. When it is impractical to sample at the discharge end, a sample will be taken at the time of discharge from the delivery equipment and correlation testing will be performed and documented to ensure specification requirements are met at the discharge end.

4.3.2. **Testing of Fresh Concrete**.

- Temperature. Tex-422-A.
- In-Place Field Density Testing. Tex-451-A (ASTM C-1040)
- Making and Curing Strength Specimens. ASTM C-1435 and ASTM C-31 (for cast-in-place concrete).

4.3.3. **Testing of Hardened Concrete.** Only compressive strength testing in accordance with Tex-418-A will be used unless otherwise specified or shown on the plans.

4.3.4. **Quality Control Test Specimens.** For each day's production, up to 1500 cubic yards of mix produced, prepare at least two sets of test specimens in accordance with ASTM C-1435 and ASTM C-31 under the direct observation of the Engineer or Engineer's representative. A set of specimens consists of three cylinders. Make an additional two sets for each additional 1500 cubic yards or fraction thereof. Cure and transport the specimens to the Contractor's curing tank. The Engineer will test two cylinders for compressive strength in accordance with Tex-418-a at 7 days. If the measured compressive strength between two cylinders varies by more than 10 percent of the stronger cylinder, the Engineer will test the third cylinder and average the results of the three cylinders. Otherwise, the Engineer will average the measured compressive strengths of the two cylinders tested at 28 days to determine the compressive strength of the lot.

The Engineer may adjust compressive strength targets at 7 days as production continues based on field experience.

4.4. **Mixing Process.** Use the same mixture for the entire project unless otherwise stated in the project documents. If, during production, the source of hydraulic cement, pozzolan, or aggregates is changed, then suspend production and submit a new mix design to the Engineer for approval. Do not exceed the manufacturer's rated capacity for dry concrete mixtures in the mixing chamber. Keep the sides of the mixer and mixer blades free of hardened RCC or other buildups. Routinely check mixer blades for wear and replace if wear is sufficient to cause inadequate mixing.

4.4.1. **Mixing Time.** Use a mixing time adequate to ensure a thorough and complete mixing of all materials. Do not allow the mixing time, after all materials including water are in the mixer, to be less than 1½ minutes for one cubic yard and 20 seconds for each additional cubic yard.

4.4.2. **Mixture Ingredient Tolerances.** Measure mixing water, consisting of water added to the batch, ice added to the batch, water occurring as surface moisture on the aggregates, and water introduced in the form of admixtures, by volume or weight. Measure ice by weight. Correct batch weight measurements for moisture. Ensure that the mixing plant receives the quantities of individual ingredients to within the tolerances shown in Table 2.

Table 2
Tolerances for Mixture Ingredients

Material	Variation
Cementitious Materials, wt.	± 2.0%
Water, wt or volume	± 3.0%
Aggregates, wt	± 4.0%
Admixtures, wt. or volume	± 3.0%

4.4.3. **Plant Calibration.** Prior to commencement of RCC production, carry out a complete and comprehensive calibration of the plant in accordance with the manufacturers recommended practice.

Provide all scales, containers, and other items necessary to complete the calibration. For volumetric mixers, provide test data showing mixers meet the uniformity test requirements of Tex-472-A.

4.4.4. **Daily Reports.** Supply daily plant records of production and quantities of materials used that day to the Engineer. These records may be used as a check on plant calibration.

4.5. **Transportation.** Transport the RCC pavement material from the plant to the areas to be paved in dump trucks equipped with retractable protective covers for protection from rain or excessive evaporation. Ensure that the trucks are dumped clean with no buildup or hanging of RCC material in the corners. Have the dump trucks deposit the RCC material directly into the hopper of the paver or into a secondary material distribution system that deposits the material into the paver hopper. Dump truck delivery must be timed and scheduled so that RCC material is spread and compacted within the specified time limits.

4.6. **Placing.**

4.6.1. **Subbase Condition.** Prior to RCC placement, meet the requirements of the pertinent Item for the underlying layer and ensure that the surface of the subbase is clean and free of foreign material, ponded water, and frost. Ensure that the subbase is uniformly moist at the time of RCC placement. If sprinkling of water is required to remoisten certain areas, ensure that the method of sprinkling will not form mud or pools of freestanding water.

4.6.2. **Weather Conditions.**

- **Cold Weather Precautions.** Meet the requirements of Section 360.4.7.3, "Temperature Restrictions."
- **Hot Weather Precautions.** During periods of hot weather or windy conditions, take special precautions to minimize moisture loss due to evaporation. Cooling of aggregate stockpiles by shading or the use of a fine mist may be required. Protective covers may be required on dump trucks. Keep the surface of the newly placed RCC pavement continuously moist.
- **Rain Limitations.** Conduct no placement of RCC pavement during rain conditions sufficient to be detrimental to the finished product. Placement may continue during light rain or mists provided the surface of the RCC pavement is not eroded or damaged in any way. Use dump truck covers during these periods. The Engineer may suspend paving when, in the Engineer's judgment, the rain is detrimental to the finished product.

4.6.3. **Paver Requirements.** Place all RCC with an approved paver in accordance with in Section 3.2, "Paver" and the following:

- **Filling the Paver.** Do not allow the quantity of RCC material in the paver to approach empty between loads. Maintain the material above the auger at all times during paving. Material transfer devices are allowed at the option of the contractor.
- **Stopping the Paver.** Ensure that the paver proceeds in a steady, continuous operation with minimal starts and stops, except to begin a new lane. Maximum paver speed during laydown is 10 feet per minute. Higher paver speeds may be allowed at the discretion of the Engineer if the higher speeds may be obtained without distress to the final product or cause additional starts and stops.
- **Surface Condition.** Ensure that the surface of the RCC pavement is smooth, uniform, and continuous without excessive tears, ridges, or aggregate segregation once it leaves the paver.

4.6.4. **Inaccessible/Transition Areas.** When approved by the Engineer, inaccessible areas to either the rollers or the paver, or other areas such as transitions may be paved with cast-in-place concrete in accordance with the requirements of Item 360 and CPCD-14 standard sheet or as shown in the plans.

4.6.5. **Adjacent Lane Pavement.** Place adjacent paving lanes within 60 minutes. If more than 60 minutes elapses between placement of adjacent lanes, the vertical joint must be considered a cold joint and prepared in accordance with Section 4.8.2, "Cold Vertical Joints". At the discretion of the Engineer, this time may be increased or decreased depending on ambient conditions of temperature, wind, and humidity. Multiple pavers may be used in tandem to reduce the occurrence of cold joints.

4.6.6. **Hand Spreading.** Broadcasting or fanning the RCC material across areas being compacted is not permissible. Such additions of materials may only be done immediately behind the paver and before any compaction has taken place. Remove segregated coarse aggregate from the surface before rolling.

4.6.7. **Segregation.** Suspend placement if segregation occurs in the RCC during paving operations until the cause is determined and corrected to the satisfaction of the Engineer. If the segregation is judged by the Engineer to be severe, remove and replace the segregated area at no additional cost to the Department.

4.7. **Compaction.**

4.7.1. **Time to Compaction.** Ensure that compaction begins with the placement process and is completed within 60 minutes of the start of the mixing at the plant and in compliance with the previously submitted paving plan. The time may be increased or decreased at the discretion of the Engineer depending on ambient conditions of temperature and humidity and the use of chemical admixtures. Do not delay rolling unless approved by the Engineer.

4.7.2. **Rolling.** Establish the sequence and number of passes by vibratory and non-vibratory rollers to obtain the specified density and surface finish. Only operate rollers in the vibratory mode while in motion. Rubber-tire rollers may be used for final compaction. Use additional rollers if specific density requirements are not obtained or if placing operations outpace the rolling operations.

4.7.3. **Rolling Longitudinal and Transverse Joints.** Do not operate the roller within 2 feet of the edge of a freshly placed lane until the adjacent lane is placed. Upon placement, roll both edges of the lanes simultaneously within the allowable time. If a cold joint is planned or expected, roll the complete lane and follow cold joint procedures as specified in Section 4.8.2, "Cold Vertical Joints" .

4.7.4. **Inaccessible Areas.** Compact areas inaccessible to large rollers using walk-behind rollers or hand tampers.

4.7.5. **Density Requirements.** Perform field density tests at a frequency of 2 for 1500 cubic yards placed as soon as possible, but no later than 30 minutes after the completion of the rolling. Only wet density is used for evaluation. The required minimum density is 98 percent of the maximum laboratory density obtained according to Tex-451-A (ASTM C 1040). The in-place density and moisture content may be determined with a nuclear moisture-density gauge. Calibrate the gauge for moisture content at the beginning of the work and at any time during the work. RCC properly placed and compacted, but not meeting the density requirements, shall be cored and tested at the Contractor's expense. If the tested area achieves 28-day design strength, it will be paid at the full unit price. If the tested area indicates strength less than 4,000 psi but greater than 3,650 psi, payment will be made in accordance with Table 3.

If the cores indicate strengths less than 3,650 psi at 28 days or longer, the Department will evaluate the results and may reject the affected area and require removal and replacement or elect to pay at an appropriate reduced rate. The Engineer may allow areas with strengths less than 3,650 psi to remain in place with no pay.

The area for pay adjustment will be determined by the Engineer and may be further defined by their direction for additional cores.

Table 3
Price Reduction

Compressive Strength (psi)	Price Reduction (percent of unit bid price)
3999-3800	5
3799-3650	15

4.8. **Joints.** Multiple pavers may be used in tandem to reduce the occurrence of cold joints.

4.8.1. **Fresh Vertical Joints.** A joint is considered a fresh joint when an adjacent RCC lane is placed within 60 minutes of placing the previous lane or as specified by the Engineer based on ambient conditions. The time may be increased or decreased at the discretion of the Engineer depending on ambient conditions of temperature and humidity and the use of chemical admixtures. Other than rolling procedures, fresh joints do not require special treatment.

4.8.2. **Cold Vertical Joints.** Any planned or unplanned construction joints that do not qualify as fresh joints are considered cold joints. Prior to placing fresh RCC mixture against a compacted cold vertical joint, thoroughly clean the cold joint of loose or foreign material. Wet the vertical joint face and maintain it in a moist condition immediately prior to placement of the adjacent lane.

For uncompacted surfaces or slopes more than 15 degrees from the vertical, cut the joint vertically for the full depth. Within 2 hours of final compaction, the edge of a cold joint may be cut with approved mechanical equipment. For edges cut after 2 hours, saw-cut to the full depth of the pavement.

Demonstrate any modification or substitution of the saw-cutting procedure to the Engineer for approval prior to use. In no case allow cutting of the edge to cause raveling or tearing of the surface. Moisten the cut edge immediately prior to placement of the adjacent lane.

For all longitudinal cold joints, route the joint ¼ inch wide and seal in accordance with Section 360.2.7, "Joint Sealants and Fillers."

4.8.3. **RCC Pavement Joints at Structures.** Line structures such as manholes, valves, or concrete curb and gutter with preformed joint filler in accordance with DMS-6310, "Joint Sealants and Fillers" for Class 6 Preformed Seals. Provide preformed joint fillers with a thickness equal to the width of the joint required and furnish in lengths equal to the width of the slabs in which they are installed. Use preformed joint filler shaped so that, after installation, the upper and lower surfaces conform to the shape of the slab and subbase surfaces. Position the lower surface of the preformed joint filler on or below the surface of the base while the upper surface is ½ inch below the surface of the slab unless otherwise specified.

4.8.4. **Control Joints.** Construct transverse contraction joints in the RCC pavement by sawing. Green-cut shall be utilized as soon as possible behind the rolling operation to prevent random cracking, typically one (1) to four (4) hours. Cut all joints to 1/4 the depth of the RCC pavement to a single saw blade width. Joints should be spaced at intervals of 20 ft for all pavement thicknesses and follow the guides in Section 4.1.2. Control joints shall be sealed in accordance with Section 360.2.7, "Joint Sealants and Fillers."

4.9. **Multi-lift Placements.** Do not exceed 60 minutes between the start of moist mixing and the end of compaction of any load of RCC in multi-layer construction. Where two or more layers are to be constructed consecutively, do not exceed 120 minutes between the start of moist mixing of the material for the bottom layer and completion of finish, grading, and compaction of the top layer. Grading or operating graders, compacting, or finishing is not allowed after the specified times have elapsed, however, the time may be increased or decreased at the discretion of the Engineer depending on ambient conditions of temperature and humidity and the use of chemical admixtures. Multiple pavers may be used in tandem to reduce the

occurrence of cold joints. Keep the surface of the underlying layers moist by fog-spray until covered by the next layer.

4.10. **Finishing.** Ensure that the finished surface of the RCC pavement, when tested with a 10-foot straightedge or crown surface template, does not vary from the straightedge or template by more than 1/4 inch at any one point and shall be within 5/8 inch of the specified finished grade. When surface irregularities are outside these tolerances, diamond-grind the surface to meet the tolerance. Corrective measures are at the Contractor's cost and will not be reimbursed.

For final surfaces, provide a uniform diamond grind texture on all areas under traffic prior to opening to traffic. Target a diamond grind texture of 0.04 in. as measured by Tex-436-A. Correct any location with a texture less than 0.03 in. by performing additional diamond grinding.

For surfaces where an overlay is the final riding surface, unless otherwise directed, correct grade deviations greater than 1/2 in. in 16 ft. measured longitudinally or greater than 1/2 in. over the entire width of the cross-section.

4.11. **Curing.** Immediately after final rolling and compaction testing, keep the surface of the RCC pavement continuously moist until an approved curing compound, a suitable prime coat, or a layer of asphalt concrete is applied or for 72 hours after placement, whichever comes first. Apply water cure by water trucks equipped with fog spray nozzles, soaking hoses, sprinkling system, or other means such that a uniform moist condition on the surface of the RCC is ensured. Apply this moisture in a manner that will not erode or damage the surface of the finished RCC pavement. Use either water cure or curing compound methods in Sections 4.11. 1 and 4.11.2 .

4.11.1. **Water Cure.** The use of wet mat curing is allowed in accordance with Section 420.4.10. "Curing Concrete" using interim Type 1-D curing compound and wet mats.

4.11.2. **Curing Compound.** Do not use curing compounds when the RCC material is to be promptly covered with asphalt. Apply curing compound conforming to DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants" in accordance with Section 360.4.9, "Curing" with the exception of application will be prior to texturing. Provide SS-1 emulsified asphalt conforming to Item 300, "Asphalts, Oils, and Emulsions," for concrete pavement to be overlaid with asphalt concrete under this Contract unless otherwise shown on the plans or approved. Do not use emulsified asphalt when the RCC is the final surface.

4.12. **Opening to Traffic.** Protect the RCC from vehicular traffic during the curing period. Completed portions of the RCC pavement may be opened to light construction traffic as soon as the strength is sufficient to prevent visible damage to the RCC but no sooner than 24 hours. Water trucks will be allowed on the surface after compaction for the purposes of maintaining moisture. The pavement may be opened to unrestricted traffic after 72 hours and when the strength exceeds 2,500 psi. However, if the temperature drops below 40° F, then the period of time the temperature is below 40° F will be added to the minimum time to opening. Temperature will be based on the hourly ambient air temperature reported by the nearest National Weather Service station.

4.13. **Maintenance.** Maintain the RCC pavement in good condition until all work is completed and accepted at no additional cost to the Department.

4.14. **Thickness and Thickness Tolerance.** Provide and operate equipment capable of extracting a small (approximately 1 inch diameter or greater) core to determine the pavement thickness. Extract samples in the presence of the Engineer or Engineer's representative unless otherwise directed.

Repair the core holes using a packaged quick set repair mortar such as SikaQuick 1000 or approved equivalent or a Class 4000 or better ready mix concrete. Rod and neatly strike off the repair material.

Measure the thickness in the travel lanes of the completed RCC at staggered intervals not to exceed 500 feet in length for two-lane roads. Measure the core to the nearest 0.10 inch at three different, evenly spaced locations and record the average. Where the RCC is deficient in depth by more than 0.75 inch, take an additional core within 3 feet of the original core. If the average of the 2 cores is in excess of 0.75 inches, correct the area by removal and replacement. The extent of the area of correction will be determined by the Engineer and may be further defined by their direction for additional cores. The Engineer may allow areas in excess of 0.75 inches deficient to remain in place with no pay.

Where the thickness of a core shows to be deficient by more than 0.2 inches but 0.75 inches or less, a pay adjustment will be made in accordance with Section 6, "Payment" and Table 4. The area for pay adjustment will be determined by the Engineer and may be further defined by their direction for additional cores.

Table 4
Deficient Thickness Price Adjustment Factor

Deficiency in Thickness Determined by Cores (in.)	Proportional Part of Contract Price Allowed (adjustment factor)
Not deficient	1.00
Over 0.00 through 0.20	1.00
Over 0.20 through 0.30	0.80
Over 0.30 through 0.40	0.72
Over 0.40 through 0.50	0.68
Over 0.50 through 0.75	0.57

4.15. **Ride Quality.** Unless otherwise shown on plans, measure the ride quality in accordance with Item 585, "Ride Quality for Pavement Surfaces," Surface Test Type B, with Pay Adjustment Schedule 2.

5. MEASUREMENT

RCC will be measured by the square yard completed and accepted in place. Pavement constructed outside the area designated to be paved will be not be measured for payment.

6. PAYMENT

RCC will be paid for at the unit price for RCC Pavement, of the thickness specified, which price and payment will be full compensation for furnishing all materials, equipment, tools, labor, and incidentals necessary to satisfactorily complete the work. Pavement that is deficient in thickness addressed in Section 4.14, "Thickness and Thickness Tolerance" and density/strength deficiencies addressed in Section 4.7.5, "Density Requirements," but is permitted to be left in place, will be paid at the reduced unit price as provided in Tables 3 and 4 or no pay in accordance with this Item. No compensation will be made for the materials or labor involved in the removal or replacement of defective material and for diamond grinding or other corrective measures to meet requirements.

Cast-in-place concrete placed in areas as allowed under Section 4.6.4., Inaccessible/Transition Areas, will be paid as roller compacted concrete.

Concrete curbs required will be for paid for under Item 529, "Concrete Curb, Gutter, and Combined Curb and Gutter."

PART IV - LIST OF APPENIDICIES

APPENDIX A - CITY OF SAN ANGELO APPROVED MATERIALS AND MANUFACTURERES FOR WATER AND SEWER

APPENDIX B - CITY OF SAN ANGELO APPROVED BEDDING MATERIAL SUPPLIERS

APPENDIX C – GEOTECHNICAL REPORT

APPENDIX A

City of San Angelo

Approved Materials and Manufacturers

For Water and Sewer

Prepared By:

The Department of Public Works

Engineering Services Division

June 2016

Table of Contents

Section 1 Introduction

This list includes specific products and manufacturers that have been approved for use within the City of San Angelo water distribution and sanitary sewer collection systems. This listing is intended to be used as a reference for city employees, designers, developers, contractors and vendors. Materials and manufacturers not listed herein are not acceptable for use within the city's system.

For consideration to be approved for use within the City of San Angelo water distribution and sanitary sewer collection system contact the Engineering Services Department at (325) 657-4201.

Section 2 Water Distribution System

2.1 Water Main Pipe

A) Polyvinyl Chloride (PVC) – 4-inch to 24-inch

PVC water main pipe shall be DR 18 (235 psi Pressure Rating) and conform to AWWA C900 or C905.

1. CertainTeed – Certa-Lok
2. Diamond Plastics
3. Jet Stream
4. JM Eagle
5. North American
6. Northern
7. Royal
8. Vinyltech

B) Cement-lined Ductile Iron Pipe (DIP) – 4-inch to 24-inch

Ductile iron pipe shall conform to AWWA C150 and AWWA C151.

1. American Cast Iron Pipe Company
2. McWane Pipe
3. U.S. Pipe and Foundry

C) Concrete Cylinder Pipe (CCP) – 24-inch to 48-inch

Concrete cylinder pipe shall conform to AWWA C301 or C303.

1. Hanson

2.2 Tapping Sleeve

Tapping sleeves shall be 304 stainless steel body with stainless or epoxy-coated carbon steel flange, gridded 360^{O} rubber gasket, stainless steel armor plate and hardware, coated to prevent galling or seizing, ¾" stainless steel test plug, and conform to AWWA C207 and C228.

1. Ford Fast
2. Powerseal 3480AS
3. Romac SST
4. Smith-Blair 663

2.3 Fire Hydrant

Fire hydrants shall be 30-inch standard bury depth, post type, dry barrel, traffic model with 5-1/4 inch main valve, two 2-1/2 inch hose nozzles and one 4-1/2 inch pumper nozzle with National Standard Threads (NST). Hydrants shall be painted OSHA "Safety Yellow" and shall conform to AWWA C502 & C550.

1. American Darling B-84-B

2. Clow Medallion
3. East Jordan Iron Works (EJIW) WaterMaster
4. Mueller Super Centurion A-423
5. M & H 129

2.4 Fire Hydrant Extension

Fire hydrant extensions must be of the same manufacturer and model as the hydrant they are being installed on. Standard extension sizes shall be 6", 12", 18" and 24". An extension above 24" will warrant replacement of the hydrant with an appropriate bury depth. No more than one extension per hydrant.

2.5 Gate Valve – 4-inch to 12-inch

Resilient Seated Gate Valves (RSGV) shall be ductile iron body, heat-fusion nylon or fusion bonded epoxy coated, non-rising stem, flanged or mechanical jointed, and shall conform to AWWA C504.

1. American Flow Control
2. American AVK
3. Clow
4. EJIW
5. J&S
6. Kennedy
7. Mueller
8. M&H

2.6 Butterfly Valve – 16-inch to 48-inch

Butterfly Valves shall be ductile iron body, heat-fusion nylon or fusion bonded epoxy coated, and shall conform to AWWA C504.

1. Clow
2. DeZurik
3. GA Industries
4. J&S
5. M&H
6. Mueller

2.7 Insertable Valve

A) Insertable valves shall be NSF and ANSI certified for use in a potable water system.
   1. Hydra-Stop IV-250
   2. AVT EZ Valve

2.8 Valve Box & Lid

Water valve box and lid shall be adjustable 3-piece screw type, non-locking lid marked "WATER", sized to fit 6" C900 or DI pipe and shall conform to ASTM A-48-84.

1. EJIW

2.9 Ductile Iron Fitting – Bend, Tee, Crosse, Reducer, Plug

Ductile iron fittings shall be domestic made, compact type, cement lined interior, asphaltic or fusion bonded epoxy coated exterior, and shall conform to AWWA C110 or C153.

1. American Cast Iron Pipe Company
2. North American Cast Iron Products
3. Tyler Union
4. Sigma Corporation
5. SIP
6. Star Pipe Products

2.10 Ductile Iron Couplings – Transition or Straight

Couplings shall be standard body length, heat-fusion nylon or fusion bonded epoxy coated and shall conform to AWWA C219

1. Dresser
2. Ford
3. JCM
4. Romac
5. Smith-Blair

2.11 Mechanical Joint Restraint

Mechanical joint restraints shall be ductile iron body, heat-fusion nylon or fusion bonded epoxy coated and shall conform to ASTM F1674.

1. EBAA Iron (Megalug)
2. Ford
3. Smith-Blair
4. Star

2.12 Water Service Pipe

A) Polyvinyl Chloride (PVC) – 2-inch

2" PVC service line pipe shall be IPS Schedule 40 with glue type joints, Schedule 80 fittings, and shall conform to ASTM D1785.

1. Charlotte
2. Diamond
3. Jet Stream
4. JM Eagle
5. North American
6. Northern
7. Royal
8. Texas United

B) Copper Tubing (CT) – 1-inch

Copper tubing shall be domestic made, CTS, type K, soft, and conform to ASTM B88.

1. Cambridge Lee

2. Cerro
3. Halstead
4. Wieland

2.13 Service Saddle

A) 2-inch

2" service saddles shall be bronze body, bronze double strap with bronze nuts, female iron pipe threaded outlet, and shall conform to AWWA C800.

1. Ford 202-B
2. James Jones J-979
3. Mueller BR2B
4. Romac 202-B

B) 1-inch

1" service saddles shall be bronze body, bronze double strap with bronze nuts, female CC/AWWA taper threaded outlet, and shall conform to AWWA C800.

1. Ford 202-B
2. James Jones J-979
3. Mueller BR2B
4. Romac 202-B

2.14 Service Valve

A) Brass Gate Valve – 2-inch

2" gate valves shall be brass body, full port, female iron pipe threaded inlet and outlet, non-rising stem with bronze hand wheel and NSF approval for potable water.

1. Hammond
2. Milwuakee

B) Corporation Stop – 1-inch

1" corporation stops shall be no-lead bronze, full-port ball valve, 1" male AWWA/CC taper threaded inlet by 1" flared copper tube size outlet with nut, and shall conform to AWWA C800.

1. Ford F-600-4NL
2. James Jones E-1500
3. McDonald 74701
4. Mueller H-15000N

C) Angle Stop – 1-inch

1" angle stops shall be no-lead bronze, 1" flared copper tube size inlet by 1-1/4" swivel meter coupling nut outlet with lockwing tee head, and shall conform to AWWA C800.

1. Ford KV23-444W
2. James Jones J-1525
3. McDonald 4622
4. Mueller H-14255

2.15 Backflow Preventer

Double Check, Double-Detector Check and Reduced Pressure Prevention Backflow Preventers shall have the American Society of Sanitation Engineering Seal of Approval and be installed as specified by TCEQ regulations.

1. Ames
2. FebCo
3. Watts
4. Wilkins

2.16 Air Release Valve and Air/Vacuum Valve

Air release and combination air/vacuum valves shall be:

1. APCO - DeZurik
2. ARI
3. Cla-Val
4. Crespin

2.17 Check Valves

Swing Check valves shall meet AWWA C508.

1. American
2. AVK
3. Clow
4. EJIW
5. Mueller
6. M & H

2.18 Casing Spacer

Casing spacers shall be polyethylene injection molded.

1. Advance Products
2. BMW
3. Calpico
4. Cascade
5. CCI Pipeline Systems
6. PSI

2.19 End Seal

End seals shall be pull-on or wrap-around type.

1. Advance Products
2. BMW
3. Calpico
4. Cascade
5. CCI Pipeline Systems
6. PSI

2.20 Precast Concrete Vault

Precast concrete vaults shall be HS-20 load rated.

1. Capital Concrete
2. Hanson
3. Turner
4. Tyler
5. Vaughn

2.21 Precast Concrete Vault Door

Precast concrete vault doors shall be H-20 load rated, double-leaf, heavy duty diamond-plated aluminum, with hold-open arm and slam latch.

1. Bilco
2. EJIW
3. Halliday

2.22 Tracer Wire

Tracer wire shall be 14-gauge, HDPE-coated copper/steel wire manufactured for direct burial.

1. Agave Wire
2. Copperhead
3. Southwire

2.23 Detectable Marking Tape

Marking tape shall be 2-inch, color coded blue for water.

1. Accucast
2. Presco
3. Pro-Line
4. Terra Tape

Section 3 Sewer Collection System

3.1 Gravity Sewer Pipe

A) PVC – 4-inch to 15-inch

4" – 15" PVC gravity sewer main pipe shall be SDR 35 or SDR 26 and conform to ASTM D3034.

1. Diamond Plastics
2. Jet Stream
3. JM Eagle
4. Northern
5. North American
6. Royal

B) PVC – 18-inch to 36-inch

18" – 36" PVC gravity sewer main pipe shall be SDR 26 and conform to ASTM F679.

1. Diamond Plastics
2. Jet Stream
3. JM Eagle
4. Northern
5. North American

3.2 Pressure Sewer Pipe and Fitting

PVC pipe and fittings used for pressurized sewer applications shall meet the requirements established in the water section of this list, except that the pipe shall be green in color.

3.3 Gravity Sewer Fitting

Sewer fittings shall be PVC of the same class as the pipe. Wyes and tees shall be swept type.

1. GPK
2. Royal
3. Spears

3.4 Manhole

A) Precast Concrete

Precast concrete manholes shall have gasketed riser connections and conform to ASTM C478.

1. Hanson
2. Locke Solutions
3. Turner
4. Tyler
5. Vaughn

B) Glass-Fiber Reinforced Polyester Manholes, Wetwells and Manhole Liners

Fiberglass manholes, wetwells and liners shall conform to ASTM D3753.

1. LFM
2. Containment Solutions

3.5 Manhole Frame & Cover (30")

A) Manhole Frame

Sanitary sewer manhole frame shall be cast iron, H-20 load rated bottom flange type, coated with bituminous emulsified asphalt, and conform to ASTM A48.

1. East Jordan

B) Manhole Cover

Sanitary sewer manhole cover shall be ductile iron, H-20 load rated, with pick-bar lifting rings, coated with bituminous emulsified asphalt, and conform to ASTM A48. Cover shall be marked "City of San Angelo Sanitary Sewer".

1. East Jordan

3.6 Cleanout Boot & Lid

Sanitary sewer cleanout boot shall be 18-1/8" wide, 28" long and 10-1/2" high. Lid shall have nominal outside diameter of 7-1/2" with two pick holes. Boot and Lid shall conform to ASTM A-48-84.

1. East Jordan

3.7 Manhole Coatings & Protective Lining System

Manhole coatings and protective liners shall be:

1. A-Lok – Dura Plate 100 PVC Liner
2. Raven 405
3. Tnemec – Series 431 PermaShield

3.8 Manhole Joint Sealant

Manhole joint sealant shall be:

1. RamNek
2. ConSeal 102

3.9 Inflow Prevention Device

Inflow prevention devices (IPDs) shall be non-corrodible with self-cleaning gas relieve and vacuum relief valve.

1. LFM – Rain Guard
2. NoFlow-InFlow
3. The Man Pan
4. Southwestern Packing and Seals, Inc. – Rainstopper

3.10 Service Saddle

Service saddles shall be:

1. Fernco
2. Mission
3. NDS

3.11 Sewage Combination Air/Vacuum Valve

Air/Vacuum Valves shall be designed and intended for use with sanitary sewer.

1. APCO - DeZurik
2. ARI

3. Cla-Val
4. Golden Anderson

3.12 Check Valve

Swing Check and Ball Check Valves shall be designed and intended for use in sanitary sewer.

1. American
2. AVK
3. Clow
4. EJIW
5. Mueller
6. M & H

3.13 Wastewater Pump

Wastewater pumps shall be:

1. Flygt N-Pump

3.14 Tracer Wire

Tracer wire shall be 14-gauge, HDPE-coated copper/steel wire manufactured for direct burial.

1. Agave Wire
2. Copperhead
3. Southwire

3.15 Detectable Marking Tape

Marking tape shall be 3-inch, color coded green for sewer.

1. Accucast
2. Presco
3. Pro-Line
4. Terra Tape

APPENDIX B

The City Of

San Angelo, Texas

Engineering Services Department
72 W College Avenue, San Angelo, TX 76903

APPROVED BEDDING MATERIAL SUPPLIERS

COMPANY	MATERIAL	CONTACT	ADDRESS	PHONE #
CSA Materials	Type D Bedding	James O'brien	3001 Foster Rd, San Angelo, TX 76903	(432) 664-9794
SANCO Materials	Torpedo Bedding	Richard Bryan	1816 Double Barrel Rd, Bronte, TX 76933	(325) 473-2090
River Road Aggregates	COSA 3/8 Bedding	Louis De Luna	1082 CR 297, Runnels County, Bronte, TX 76865	(325) 263-7625
Tom Green Ready Mix	3/8" Pea Gravel	Roy Acosta	4195 Porter Henderson Drive, San Angelo, TX 76905	(325) 939-1166
Vulcan Materials	HMA Grade 5	Kevin Boyd	P.O. Box 518 Brownwood, TX 76804	(817) 304-9830
West Texas Rock Resources	COSA Bedding	Cheyenne Smith	P.O. Box 871 Roscoe, TX 79545	(325) 766-3033

COSA Contact: Joe Mangrem
(325) 657-4201

Spec Reference: Bedding Material for Water and Sewer Main Installation memo dated 12/29/2014.

APPENDIX C

GEOTECHNICAL ENGINEERING STUDY
BELL STREET
FROM RIO CONCHO DRIVE TO OLD BALLINGER HIGHWAY
SAN ANGELO, TEXAS

Prepared For:
FREESE AND NICHOLS, INC.
Lubbock, Texas

Prepared by:
CMT ENGINEERING, INC.
Lubbock, Texas

Report No. CMT16-001
June 6, 2016

CMT Engineering
12804 CR 2500
Lubbock, Texas 79404
p| 806.771.7283
f | 806.771.7062

June 6, 2016
Project No. CMT16-001

Mrs. Heather Keister, P.E., CFM
Project Manager
Freese and Nichols, Inc.
2732 82nd Street, Suite A
Lubbock, Texas 79423

Subject: Geotechnical Engineering Study
Bell Street
From Rio Concho Drive to Old Ballinger Highway
San Angelo, Texas

Dear Mrs. Keister:

This report presents the results of a geotechnical study performed for the referenced project in San Angelo, Texas. This study was performed in accordance with our Proposal dated January 8, 2016.

Our engineering analysis as well as the results of the field exploration and laboratory testing is included in this report. Our firm is interested in providing the professional material testing that will be required during the construction phase of the project.

We appreciate the opportunity to be of assistance on this project. Please feel free to contact us if you have any questions or if we can be of further service.

Sincerely,

CMT ENGINEERING, INC.
TBPE Firm Registration No. 13112

STATE OF TEXAS
COLE T. HUTSON
118779
LICENSED
PROFESSIONAL ENGINEER
6/6/16

Cole Hutson, P.E.
Project Manager

Bryan Wilson, P.E.
Vice President

Copies Submitted: 1 (via email)

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GEOTECHNICAL ENGINEERING STUDY
BELL STREET
FROM RIO CONCHO DRIVE TO OLD BALLINGER HIGHWAY
SAN ANGELO, TEXAS

1 INTRODUCTION

1.1 PROJECT AND SITE DESCRIPTION

This report presents the results of the geotechnical study for Bell Street from Rio Concho Drive to Old Ballinger Highway in San Angelo, Texas. The site is located on the Eastern side of San Angelo as shown on the Vicinity Map, Figure 1 included in Appendix A.

The project consists of full depth reconstruction extending from Rio Concho Drive to US 67 and from US 67 to Old Ballinger Highway. The existing pavement will be removed and replaced with a new hot mixed asphaltic concrete (HMAC) pavement section. We have assumed that the reconstruction will generally match the existing grades. Recommendations for HMAC are provided in this report.

1.2 PURPOSE AND SCOPE OF WORK

The purpose of this study was to evaluate the subsurface conditions at the site and to develop geotechnical engineering recommendations for the proposed pavement section. To accomplish the intended purposes, the study has been conducted based on the following scope:

- Exploration and evaluation of the soil and rock strata at the boring locations;
- Evaluation of soil swell potential;
- Perform laboratory tests on selected samples to determine classification and engineering properties of the subsurface soil;
- Recommendations for HMAC pavement sections; and
- Discussion of construction considerations.

2 FIELD EXPLORATION

The subsurface material at the project site was explored by drilling fourteen (14) borings on March 17, 2016 and March 25, 2016. Due to traffic control and utility conflicts, Borings B15 through B17 could not be completed as part of our field investigation.

The borings were drilled to depths of ten (10) and twenty (20) feet below the existing grade at the approximate location as shown on the Plans of Borings (POB's), Figure 2 in Appendix A. The Logs of Borings and a key to terms and descriptions on the logs are provided in Appendix B of this report.

At selected depths, disturbed samples of non-cohesive soils, and/or hard cohesive materials were collected by driving a split-spoon sampler in conjunction with the Standard Penetration Test (SPT). This technique involves driving the spoon sampler a distance into the soil using a free-falling hammer (based upon ASTM D 1586). During the test, the logger records the number of blows required to drive the spoon sampler over three successive 6-inch increments. The first 6 inches is the "seating drive," while the number of blows required to drive the sampler the last two 6-inch increments is the "penetration" in blows per foot. Where resistance is high, the number of inches of penetration for 50 blows of the hammer is recorded. When less than 6 inches of penetration is obtained, the test is terminated regardless of the drive increment. The results of the penetration test are reported on the boring log at the corresponding depth. Materials recovered from the split-spoon sampler are then placed in a plastic bag to protect the sample and to reduce moisture loss. The boreholes were backfilled with soil cuttings and asphalt (cold) patch at the surface, wherever needed, upon completion of drilling.

Field boring logs were prepared by a soils technician as part of the drilling operations. The boring logs include visual classifications of the materials encountered during drilling and the loggers' interpretation of the subsurface conditions between samples. The final boring logs included in this report represent the engineer's interpretation of the field logs and include modifications based on observations and testing of the samples in the laboratory. Soil strata boundaries shown on the boring logs are approximate. The stratification boundaries shown on the boring logs represent the approximate locations of the changes in the soil and rock types; in situ, the transition between material types may be gradual and indistinct.

The boring locations should be considered accurate only to the degree implied by the method used in its determination. If a greater degree of accuracy is required or desired, then a licensed land surveyor should be retained to record the coordinates of the borings.

3 LABORATORY TESTING

Samples were examined at our laboratory by the project manager. Classification tests performed for this study included liquid and plastic limits, moisture contents, and percent fines passing #200 Sieve tests. Results of these tests are presented on the boring logs. All tests were performed in accordance with the applicable ASTM methods.

4 SUBSURFACE CONDITIONS

4.1 GEOLOGY

Atlas maps published by the Bureau of Economic Geology at the University of Texas, Austin indicated that the site is located within caliche and gravel deposits with playa deposits scattered intermittently throughout the area. Due to the sporadic depositional characteristics, it is not uncommon to find clay deposits as well. The Playa deposits are formed by the formation of small lakes formed on the surface and consist of clay and silt and are typically light gray in color.

4.2 SUBSURFACE CONDITIONS

Specific types and depths of subsurface strata encountered in the borings are shown on the boring logs along with the existing pavement structure. The subsurface conditions encountered at the subject site can be generalized as shown below:

> Approximately 20 feet of tan to light reddish brown sandy clay or clayey sand with caliche and limestone cobble to the termination depth of the borings. Varying thickness of fat clay was encountered in Borings B2, B12 and B15.

Based on Atterberg Limits (Liquid Limit and Plastic Limit) test results, the soils encountered in the borings are considered to be moderately expansive.

Refer to the Logs of Borings in Appendix B for detailed subsurface descriptions. Note that demarcation lines between the strata are interpretive of the field conditions, and that actual strata transitions in the field may be gradual.

4.3 GROUNDWATER CONDITIONS

The borings were advanced with an air rotary drilling rig. These methods allow relatively accurate groundwater observations to be made while drilling. Groundwater was not encountered during drilling. The borings were dry during and upon completion of drilling.

It is not possible to accurately predict the magnitude of subsurface water fluctuations that might occur based upon short-term observations. The occurrence and variation of groundwater can vary due to many factors. These factors include seasonal changes, site topography, surface runoff, the layering and permeability of subsurface strata; water levels in waterways, utilities, and other factors not evident at the time of this study. The possibility of groundwater and its fluctuation should be considered when developing this project.

5 ANALYSIS AND ENGINEERING RECOMMENDATIONS

At the time this report was written finished grades were not available. We anticipate that the finished grade of the roadway will be within ±1 foot of the existing grade.

5.1 POTENTIAL VERTICAL SOIL MOVEMENT

The subgrade at this site includes moderately expansive soil that may exhibit moderate shrink and swell behavior. The amount of shrink/swell behavior that can occur will depend upon moisture fluctuations of the subgrade soils that occur over the design life of the pavement. Generally, the magnitude of soil potential vertical movements (PVM's) are dependent upon the moisture content, thickness and nature of the soils present below finished grade at the time of construction, the preceding and prevailing

atmospheric conditions, the overall drainage characteristics of the site surface, and the depth of the active moisture zone.

The finished grade and/or the depth of cut and fill of the proposed street were unknown at the time of this report writing. Therefore, PVM calculations for the proposed roadway were performed using the Texas Department of Transportation (TxDOT) Method 124-E at existing grade. The TxDOT method is empirical and is based on the Liquid and Plastic Limits and moisture content of the subsurface soils. Using the TxDOT method, a PVM on the order of 1.5 inches was estimated for dry soil moisture condition, which also represents the existing soil moisture condition.

The subsurface soil conditions encountered in the borings and results of the laboratory tests performed during this study indicate that the soils were at dry to average moisture states at the time the borings were advanced. It should be noted that the amount of PVM is dependent on the moisture condition of the soil sample at the time it is sampled and tested. The higher the initial moisture content, the lower the PVM and vice-versa. However, considerably more movement may occur in areas where the subgrade soils are allowed to dry and where water ponding is allowed to occur during or after construction.

5.2 SITE AND SURFACE DRAINAGE

All grades must be adjusted to provide positive drainage. Water permitted to pond near or adjacent to the roadway can result in soil movements which exceed those discussed in this report. Maximum grades practical should be used for paving and flatwork to prevent areas where water can pond. Irrigation systems should be carefully designed and constructed to prevent saturation of the subgrade soil below the pavement section.

6 EARTHWORK RECOMMENDATIONS

6.1 SITE PREPARATION AND PROOFROLLING

All existing pavement, surface vegetation, organic topsoil, gravel surface, loose materials, loose fill, and/or any debris or deleterious matter should be removed. Following excavation, the exposed soil should be proofrolled to expose any weak, soft, wet, or otherwise unsuitable soils. The subgrade should be proofrolled (under the

observation of qualified personnel) with a loaded, tandem-axle dump truck weighing a minimum of 25 tons, or other heavy, rubber-tired construction vehicle, to locate any zones that are soft, loose or unstable. The proofrolling should consist of several overlapping passes in mutually perpendicular directions over a given area. The subgrade in areas where rutting or pumping occurs during proofrolling should be removed to hard ground and replaced with suitable fill, as described below, if it cannot be compacted in place.

If fills are required to get to grade, the exposed subgrade should be scarified to a depth of 12 inches, watered as required and re-compacted to a minimum of 95 percent of the maximum dry density as defined by Test Method Tex-114-E at moisture content within two (2) percent of optimum moisture. The site may then be filled to grade using on-site soils, imported materials (borrow) similar to on-site soils or select fill meeting the requirements presented below, free from deleterious matter and no rock larger than 4 inches in size. Fill materials should be placed in six (6) to eight (8)-inch loose lifts at moisture contents within two (2) percent of optimum and each lift compacted to a minimum of 95 percent of its maximum dry density as defined by Test Method Tex-114-E. Field density tests should be taken in accordance with the Test Method Tex-115-E at the rate of one test per each 2,500 square feet or a minimum of three per lift in the area of all compacted fills. For areas where hand tamping is required, the testing frequency should be increased to approximately one test, per lift, per 100 linear feet of area.

6.2 SELECT FILL CRITERIA

The non-expansive select fill material should be very sandy lean clay to clayey sand with a Liquid Limit (LL) of less than 35 percent and a Plasticity Index (PI) between 6 and 15. The on-site or the borrow material could be conditioned with clean sand to produce a suitable material meeting the requirements stated above. The existing material should be uniformly blended and should be tested for conformance after the blending is complete. The process for blending the material should be at the contractors' discretion.

The select fill should be spread in loose lifts, less than 8 inches thick and uniformly compacted to a minimum of 95 percent of Tex-114-E within ± 2 percentage points of the soil's optimum moisture content. The first lift of select fill should be placed wet of optimum to prevent drying the underlying subgrade. Positive drainage must be

provided away from the pavement to prevent the ponding of water in the select fill, during and following construction.

If flexible base materials (crushed limestone) is used as non-expansive select fill it should follow Item 247, Type D, Grade 1-2 as outlined in the Texas Department of Transportation, Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges, 2014 Edition. The material should be placed in 6-inch lifts and compacted to a minimum of 95 percent of Tex-113-E, within 2 percent of optimum moisture.

7 PAVEMENT ANALYSIS

7.1 PAVEMENT SUBGRADES

Subsurface soil conditions encountered in the borings indicated that subgrade material beneath the pavement at this site is anticipated to be sandy clay with caliche. The subgrade is subject to loss of support with the moisture increases that can occur beneath paving. Pavement subgrade should be graded to prevent ponding and infiltration of excessive moisture on or adjacent to the pavement subgrade surface.

7.2 PAVEMENT SECTIONS

The proposed project will require heavy duty paving, with a flexible pavement system under consideration. It should be noted that a flexible pavement system will require frequent repair and maintenance during the period of design life of the pavement.

The pavement thickness calculations were performed using the following parameters that were developed based on traffic data provided by Freese and Nichols, Inc., and the procedures outlined by the American Association of State Highway and Transportation Officials (AASHTO). Based on the provided traffic data, the following ESAL's (Table 7.1) are considered for our pavement recommendations.

Table 7.1 – Pavement Design Loading

Location	Unit Type	Type of Pavement	[1]ESAL
Bell Street (Between Rio Concho Drive and US 67)	Mixed Traffic (Trash/Delivery Trucks and Light Duty AUTO's)	Heavy-Duty	12,950,741
Bell Street (Between US 67 and Old Ballinger Highway)	Mixed Traffic (Trash/Delivery Trucks and Light Duty AUTO's)	Heavy-Duty	8,511,086

(1) -Equivalent Single Axle Load (ESAL) for a 20 year design life.

When appropriate, the item listed in the parenthesis at the end of each bullet item refers to the source of the value.

- 20 year Design Life
- 80% Reliability (assumed, AASHTO)
- 0.45 Overall Deviation (AASHTO)
- 10,426 psi Subgrade Resilient Modulus (based on assumed CBR of 9)
- Drainage Coefficient = 1.0 (assumed, AASHTO)
- 4.2 Initial Serviceability (AASHTO)
- 2.0 Terminal Serviceability (AASHTO)
- Layer Coefficients of 0.40 Asphalt Cement Concrete Surface Course, 0.40 for Asphalt Treated Base Course, and 0.14 for Crushed Stone Base (assumed)

Based on our analysis, we recommend that the following pavement sections (Table 7.2) be considered for the construction of the proposed street. The proposed pavement sections will provide adequate support for the design traffic as indicated in aforementioned Table 7.1.

Table 7.2 – Bell Street Recommended Pavement Thicknesses

Pavement Type/Location	Flexible Section
Heavy Duty / Rio Concho Drive to US 67	3.0 Inches of HMAC Surface Course 3.0 Inches of HMAC Base Course 12.0 Inches of Crushed Stone Base 12.0 Inches Compacted Subgrade
Heavy Duty / US 67 to Old Ballinger Highway	3.0 Inches of HMAC Surface Course 3.0 Inches of HMAC Base Course 10.0 Inches of Crushed Stone Base 12.0 Inches Compacted Subgrade

The recommended pavement section is intended to provide an adequate thickness of structural materials, such that wheel loads are distributed over a larger area. The pavement may be adequate from a structural standpoint, yet still experience cracking and deformation due to soil movements below the section. Therefore, moisture changes in the subgrade should be prevented. The pavement and adjacent areas should be well drained. Proper and regular maintenance should be performed on cracks in the pavement surface to prevent water passing through to the base or sub-base material. Even with these precautions, some movements and cracking may still occur, which will require periodic maintenance.

7.3 PAVEMENT MATERIAL SPECIFICATIONS

Recommended material specifications for the recommended pavement sections are provided below. Refer to the Texas department of Transportation Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges, 2014 Edition for TxDOT Items.

Hot Mix Asphaltic Concrete Surface Course - TxDOT Item 340, Type D.
(HMAC Surface Course)

Hot Mix Asphaltic Concrete Base Course - TxDOT Item 340, Type B.
(HMAC Base Course)

Flexible Base Material (Crushed Stone Base) - TxDOT Item 247, Flexible Base Material, Type A, Grade 2 or better. Note that it may be necessary to reduce the lift thickness to achieve the desired compaction.

7.4 PREVENTATIVE MAINTENANCE

Differential soil movements can occur that can cause pavement cracking and opening of joints. Water entering joints can reduce the service life of the pavement. Preventative maintenance should be provided for through and on-going pavement management program to enhance future pavement performance. Preventative maintenance activities are intended to slow the rate of pavement deterioration and to preserve the pavement investment.

Preventative maintenance consists of both localized maintenance (e.g. crack and joint sealing and patching) and global maintenance. Preventative maintenance is usually the first priority when implementing a planned pavement maintenance program and provides the highest return on investment for pavements. Also, thicker pavement sections could be used to reduce the required maintenance and extend the service life of the pavement. Prior to implementing any maintenance, additional engineering observation is recommended to determine the type and extent of preventative maintenance.

8 LIMITATIONS

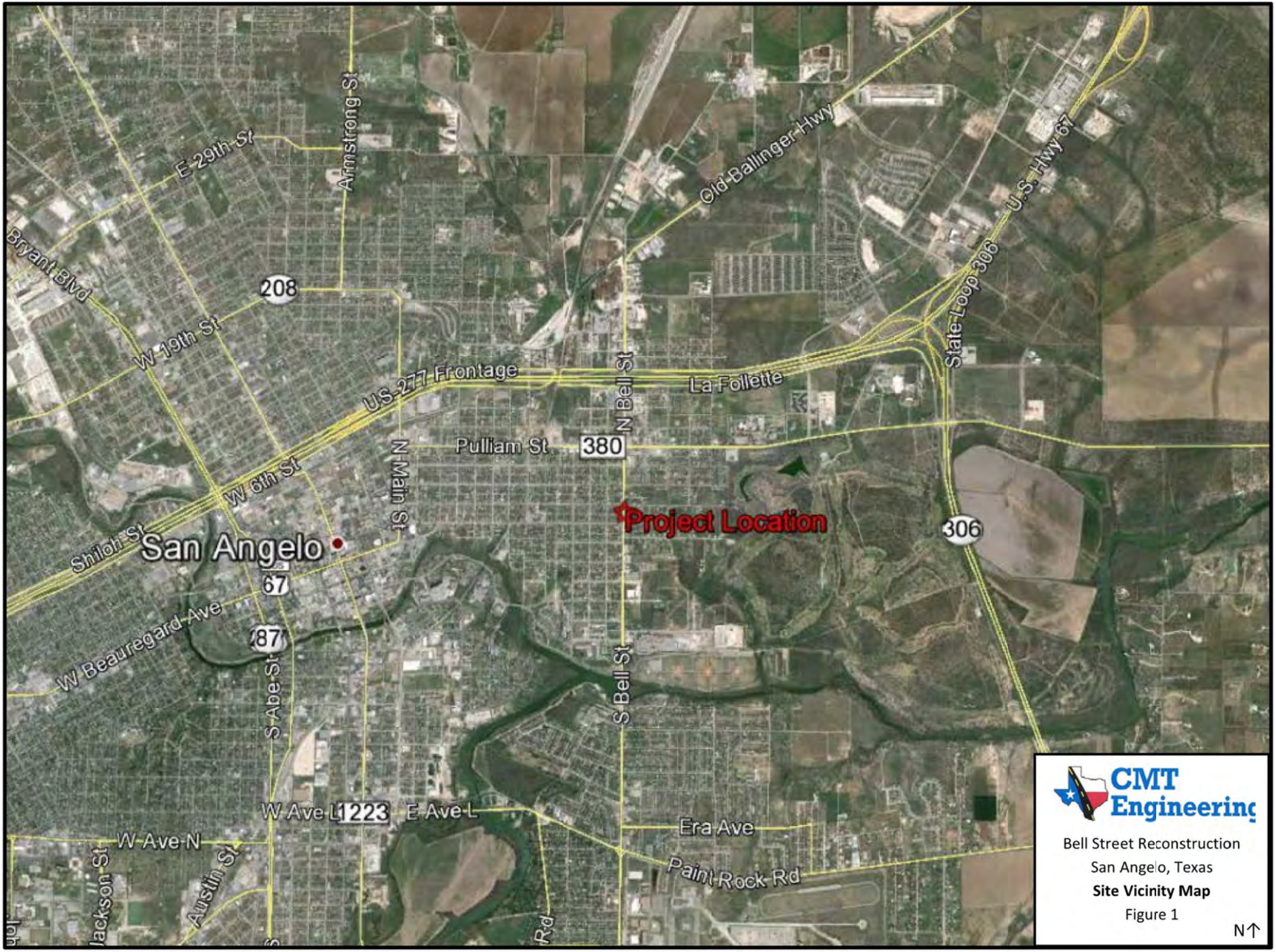
In preparation of this report, we have strived to perform our services in a manner consistent with that level of care and skill ordinarily exercised by other members of our profession currently practicing in the same locality under similar conditions and at the time the services are provided. The results, conclusions, opinions and recommendations provided in this report are directed at, and intended to be utilized within, the scope of work contained in the proposal and agreement executed by CMT Engineering and the client. These are based on a limited number of observations and data. It is possible that conditions could vary between or beyond the data evaluated. CMT Engineering, Inc. makes no other representation, guarantee or warranty, express or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided.

This report may be used only by the client and the registered design professional in responsible charge and only for the purposes stated for this specific engagement within a reasonable time from its issuance, but in no event later than two (2) years from the date of the report.

The scope of services was limited to the borings completed at the site. It should be recognized that definition and evaluation of subsurface conditions are difficult. Since some variation was found in subsurface conditions at the specific boring locations for this study, all readers should be aware that a greater variation could occur between the boring locations. Statements in the report as to subsurface variations across the site are intended only as estimations from the data obtained at specific boring locations.

The scope of services did not include environmental assessments or evaluations regarding the presence or absence of wetlands or hazardous substances in the soil, surface water, or groundwater at this site.

APPENDIX A



CMT Engineering

Bell Street Reconstruction
San Angelo, Texas
Site Vicinity Map
Figure 1

N↑

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Bell Street Reconstruction
San Angelo, Texas
Plan of Borings
Figure 2

N→

APPENDIX B

CMT Engineering, Inc.
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Lubbock, Texas
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Fax: (806) 771-7062

BORING NUMBER B1

CLIENT Freese and Nichols, Inc.
PROJECT NAME Bell Street Roadway Improvements
PROJECT NUMBER CMT16-001
PROJECT LOCATION San Angelo, Texas
DATE STARTED 3/17/16 **COMPLETED** 3/17/16
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR White Drilling
GROUND WATER LEVELS:
DRILLING METHOD Air Rotary
AT TIME OF DRILLING --- Not Encountered
LOGGED BY CTH **CHECKED BY** CTH
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		4.0" of HMAC										
		16.0" of Flexible Base										
		CLAYEY SAND, (SC) tan with caliche and limestone cobble, medium dense, dry	SPT		10-10-15 (25)			9	37	14	23	48
		SANDY LEAN CLAY, (CL) brown with caliche nodules, medium stiff to very stiff, dry	SPT		8-8-8 (16)							
5			SPT		3-4-4 (8)			9	32	14	18	67
			SPT		4-6-6 (12)							
10			SPT		9-10-12 (22)							

Bottom of borehole at 10.0 feet.

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Lubbock, Texas
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BORING NUMBER B2

CLIENT Freese and Nichols, Inc.
PROJECT NAME Bell Street Roadway Improvements
PROJECT NUMBER CMT16-001
PROJECT LOCATION San Angelo, Texas
DATE STARTED 3/25/16 **COMPLETED** 3/25/16
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR White Drilling
GROUND WATER LEVELS:
DRILLING METHOD Air Rotary
AT TIME OF DRILLING --- Not Encountered
LOGGED BY AV **CHECKED BY** CTH
AT END OF DRILLING ---
NOTES _____
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		4.0" of HMAC										
		14.0" of Flexible Base										
		CLAYEY SAND, (SC) light reddish brown with caliche, loose to medium dense, moist	SPT		5-4-5 (9)			16	33	15	18	48
			SPT		4-7-7 (14)							
5		FAT CLAY WITH SAND, (CH) gray, hard, moist										
			SPT		11-21-29 (50)			17	54	15	39	86
		SANDY LEAN CLAY, (CL) tan with caliche and limestone cobble, hard, dry										
			SPT		50/6"							
10												
			SPT		50/5"							
15												
			SPT		50/4"							

Bottom of borehole at 18.8 feet.

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BORING NUMBER B3

CLIENT Freese and Nichols, Inc.
PROJECT NAME Bell Street Roadway Improvements
PROJECT NUMBER CMT16-001
PROJECT LOCATION San Angelo, Texas
DATE STARTED 3/17/16 **COMPLETED** 3/17/16
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR White Drilling
GROUND WATER LEVELS:
DRILLING METHOD Air Rotary
AT TIME OF DRILLING --- Not Encountered
LOGGED BY CTH **CHECKED BY** CTH
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		4.0" of HMAC										
		6.0" of Flexible Base										
		SANDY CLAY, (CL) tan with caliche and limestone cobble, hard, dry	SPT		9-17-16 (33)			15	37	18	19	56
			SPT		10-16-25 (41)			13	47	17	30	87
5			SPT		20-29-35 (64)							
			SPT		23-50/3"							

Bottom of borehole at 9.3 feet.

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BORING NUMBER B4

CLIENT Freese and Nichols, Inc.
PROJECT NAME Bell Street Roadway Improvements
PROJECT NUMBER CMT16-001
PROJECT LOCATION San Angelo, Texas
DATE STARTED 3/25/16 **COMPLETED** 3/25/16
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR White Drilling
GROUND WATER LEVELS:
DRILLING METHOD Air Rotary
AT TIME OF DRILLING --- Not Encountered
LOGGED BY AV **CHECKED BY** CTH
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		4.0" of HMAC										
		6.5" of Flexible Base										
		SANDY LEAN CLAY, (CL) dark brown, very stiff, dry	SPT		8-6-19 (25)			20	36	14	22	56
		SANDY LEAN CLAY, (CL) tan with caliche and limestone cobble, very stiff to hard, dry	SPT		13-8-8 (16)			12	30	17	13	73
5			SPT		12-21-25 (46)							
			SPT		20-43-50/4"							
10												
			SPT		50/5"							
15												
		Bottom of borehole at 18.6 feet.	SPT		50/1"							

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BORING NUMBER B5

CLIENT Freese and Nichols, Inc.
PROJECT NAME Bell Street Roadway Improvements
PROJECT NUMBER CMT16-001
PROJECT LOCATION San Angelo, Texas
DATE STARTED 3/17/16 **COMPLETED** 3/17/16
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR White Drilling
GROUND WATER LEVELS:
DRILLING METHOD Air Rotary
AT TIME OF DRILLING --- Not Encountered
LOGGED BY CTH **CHECKED BY** CTH
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		4.0" of HMAC										
		6.0" of Flexible Base										
		CLAYEY SAND, (SC) tan with caliche and limestone cobble, medium dense to very dense, dry	SPT		10-6-8 (14)			10	27	19	8	44
5			SPT		2-5-13 (18)							
			SPT		24-50/5"							
			SPT		50/3"							
		Bottom of borehole at 8.8 feet.										

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BORING NUMBER B6

CLIENT Freese and Nichols, Inc.
PROJECT NAME Bell Street Roadway Improvements
PROJECT NUMBER CMT16-001
PROJECT LOCATION San Angelo, Texas
DATE STARTED 3/25/16 **COMPLETED** 3/25/16
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR White Drilling
GROUND WATER LEVELS:
DRILLING METHOD Air Rotary
AT TIME OF DRILLING --- Not Encountered
LOGGED BY AV **CHECKED BY** CTH
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		4.5" of HMAC										
		10.5" of Flexible Base										
		SANDY LEAN CLAY, (CL) light reddish brown with caliche nodules, medium stiff to stiff, moist	SPT		5-6-6 (12)			19	39	14	25	67
			SPT		2-3-5 (8)			17	34	17	17	75
5		SANDY LEAN CLAY, (CL) tan with caliche and limestone cobble, hard, dry	SPT		8-50/6"							
			SPT		50/1"							
10			SPT		50/1"							
15			SPT		50/1"							
		Bottom of borehole at 18.6 feet.										

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BORING NUMBER B7

CLIENT Freese and Nichols, Inc.
PROJECT NAME Bell Street Roadway Improvements
PROJECT NUMBER CMT16-001
PROJECT LOCATION San Angelo, Texas
DATE STARTED 3/25/16 **COMPLETED** 3/25/16
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR White Drilling
GROUND WATER LEVELS:
DRILLING METHOD Air Rotary
AT TIME OF DRILLING --- Not Encountered
LOGGED BY AV **CHECKED BY** CTH
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		4.25" of HMAC										
		8.0" of Flexible Base										
		SANDY LEAN CLAY, (CL) dark reddish brown, stiff, dry	SPT		6-7-8 (15)			12	33	12	21	67
		SANDY CLAY, (CL) light brown with caliche, stiff to hard, dry	SPT		5-7-7 (14)							
5			SPT		7-10-17 (27)			11	44	13	31	79
			SPT		10-19-29 (48)							
10		Bottom of borehole at 10.0 feet.										

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BORING NUMBER B8

CLIENT Freese and Nichols, Inc.
PROJECT NAME Bell Street Roadway Improvements
PROJECT NUMBER CMT16-001
PROJECT LOCATION San Angelo, Texas
DATE STARTED 3/25/16 **COMPLETED** 3/25/16
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR White Drilling
GROUND WATER LEVELS:
DRILLING METHOD Air Rotary
AT TIME OF DRILLING --- Not Encountered
LOGGED BY AV **CHECKED BY** CTH
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		4.0" of HMAC										
		7.0" of Flexible Base										
		CLAYEY SAND, (SC) dark brown, medium dense, dry	SPT		9-7-5 (12)			12	31	13	18	24
5		SANDY CLAY, (CL) light reddish brown with caliche, stiff to hard, dry	SPT		2-4-5 (9)							
			SPT		8-11-14 (25)							
10			SPT		6-9-10 (19)			15	47	13	34	78
			SPT		7-10-13 (23)							
15		SANDY CLAY, (CL) brown, hard, moist										
		with limestone cobble	SPT		29-21-35 (56)			23	41	13	28	23
20												

Bottom of borehole at 20.0 feet.

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BORING NUMBER B9

CLIENT Freese and Nichols, Inc.
PROJECT NAME Bell Street Roadway Improvements
PROJECT NUMBER CMT16-001
PROJECT LOCATION San Angelo, Texas
DATE STARTED 3/25/16 **COMPLETED** 3/25/16
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR White Drilling
GROUND WATER LEVELS:
DRILLING METHOD Air Rotary
AT TIME OF DRILLING --- Not Encountered
LOGGED BY AV **CHECKED BY** CTH
AT END OF DRILLING ---
NOTES _____
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		4.25" of HMAC										
		8.0" of Flexible Base										
		CLAYEY GRAVEL WITH SAND, (GC) light reddish brown with caliche and limestone cobble, medium dense to very dense, dry	SPT		14-10-13 (23)							
			SPT		2-7-13 (20)							
5												
			SPT		4-18-39 (57)			3	33	16	17	15
			SPT		14-50/5"							

Bottom of borehole at 9.4 feet.

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BORING NUMBER B10

CLIENT Freese and Nichols, Inc.
PROJECT NAME Bell Street Roadway Improvements
PROJECT NUMBER CMT16-001
PROJECT LOCATION San Angelo, Texas
DATE STARTED 3/25/16 **COMPLETED** 3/25/16
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR White Drilling
GROUND WATER LEVELS:
DRILLING METHOD Air Rotary
AT TIME OF DRILLING --- Not Encountered
LOGGED BY AV **CHECKED BY** CTH
AT END OF DRILLING ---
NOTES _____
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		3.5" of HMAC										
		6.0" of rock and sand fill material										
		CLAYEY SAND, (SC) dark brown, loose to very dense, dry										
			SPT		4-4-5 (9)			16	30	12	18	48
			SPT		4-4-5 (9)							
5		becomes very dense with limestone cobble	SPT		50/1"							
			SPT		50/4"							
10												
			SPT		50/1"							
15												
		Bottom of borehole at 18.6 feet.	SPT		50/1"							

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BORING NUMBER B11

CLIENT Freese and Nichols, Inc.
PROJECT NAME Bell Street Roadway Improvements
PROJECT NUMBER CMT16-001
PROJECT LOCATION San Angelo, Texas
DATE STARTED 3/25/16 **COMPLETED** 3/25/16
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR White Drilling
GROUND WATER LEVELS:
DRILLING METHOD Air Rotary
AT TIME OF DRILLING --- Not Encountered
LOGGED BY AV **CHECKED BY** CTH
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		9.5" of HMAC										
		8.5" of sandy clay fill material										
		CLAYEY SAND, (SC) brown with caliche, loose to medium dense	SPT		15-6-9 (15)			18	32	12	20	70
			SPT		6-3-3 (6)			16	30	15	15	51
5												
			SPT		2-3-6 (9)							
			SPT		6-11-15 (26)							
10												

Bottom of borehole at 10.0 feet.

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BORING NUMBER B12

CLIENT Freese and Nichols, Inc.
PROJECT NAME Bell Street Roadway Improvements
PROJECT NUMBER CMT16-001
PROJECT LOCATION San Angelo, Texas
DATE STARTED 3/25/16 **COMPLETED** 3/25/16
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR White Drilling
GROUND WATER LEVELS:
DRILLING METHOD Air Rotary
AT TIME OF DRILLING --- Not Encountered
LOGGED BY AV **CHECKED BY** CTH
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		3.5" of HMAC 8.5" of Flexible Base										
		SANDY LEAN CLAY, (CL) dark brown, soft, moist	SPT		3-2-2 (4)			17	34	12	22	66
		SANDY LEAN CLAY, (CL) light reddish brown with caliche, stiff, dry	SPT		3-4-5 (9)							
5			SPT		3-5-8 (13)							
		FAT CLAY WITH SAND, (CH) dark brown, very stiff, dry	SPT		3-5-13 (18)			16	59	15	44	80
10		CLAYEY SAND, (SC) light reddish brown with gravel, dense to very dense, dry										
			SPT		16-28-35 (63)							
15												
			SPT		6-13-21 (34)			12	40	13	27	17
20												

Bottom of borehole at 20.0 feet.

CMT Engineering, Inc.
12804 CR 2500
Lubbock, Texas
Telephone: (806) 771-7283
Fax: (806) 771-7062

BORING NUMBER B13

CLIENT Freese and Nichols, Inc.
PROJECT NAME Bell Street Roadway Improvements
PROJECT NUMBER CMT16-001
PROJECT LOCATION San Angelo, Texas
DATE STARTED 3/25/16 **COMPLETED** 3/25/16
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR White Drilling
GROUND WATER LEVELS:
DRILLING METHOD Air Rotary
AT TIME OF DRILLING --- Not Encountered
LOGGED BY AV **CHECKED BY** CTH
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		3.25" of HMAC 8.5" of Flexible Base										
		CLAYEY SAND, (SC) tan with caliche and limestone cobble, medium dense to dense, dry	SPT		11-17-21 (38)			8	32	12	20	44
			SPT		7-2-10 (12)							
5			SPT		50/2"							
		Bottom of borehole at 8.6 feet.	SPT		50/1"							

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Fax: (806) 771-7062

BORING NUMBER B14

CLIENT Freese and Nichols, Inc.
PROJECT NAME Bell Street Roadway Improvements
PROJECT NUMBER CMT16-001
PROJECT LOCATION San Angelo, Texas
DATE STARTED 3/25/16 **COMPLETED** 3/25/16
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR White Drilling
GROUND WATER LEVELS:
DRILLING METHOD Air Rotary
AT TIME OF DRILLING --- Not Encountered
LOGGED BY AV **CHECKED BY** CTH
AT END OF DRILLING ---
NOTES _____
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		9.0" of HMAC										
		6.5" of Flexible Base										
		(SC) light reddish brown with caliche and limestone cobble, loose to very dense, dry	SPT		17-12-5 (17)			13	27	20	7	24
			SPT		4-4-4 (8)			15	32	16	16	43
5			SPT		12-17-27 (44)							
		with limestone cobble	SPT		37-50/6"							
10												
			SPT		50/1"							
15												
		Bottom of borehole at 18.6 feet.	SPT		50/1"							

CMT Engineering, Inc.
12804 CR 2500
Lubbock, Texas
Telephone: (806) 771-7283
Fax: (806) 771-7062

BORING NUMBER B18

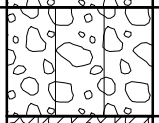
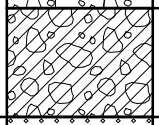
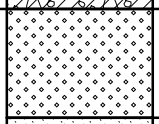
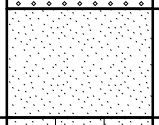
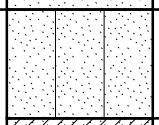
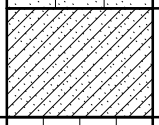
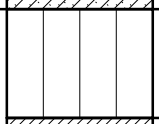
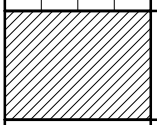
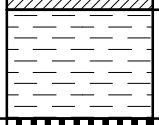
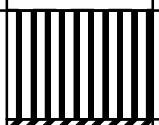
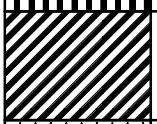
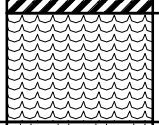
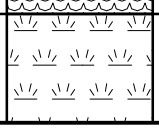
CLIENT Freese and Nichols, Inc.
PROJECT NAME Bell Street Roadway Improvements
PROJECT NUMBER CMT16-001
PROJECT LOCATION San Angelo, Texas
DATE STARTED 3/25/16 **COMPLETED** 3/25/16
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR White Drilling
GROUND WATER LEVELS:
DRILLING METHOD Air Rotary
AT TIME OF DRILLING --- Not Encountered
LOGGED BY AV **CHECKED BY** CTH
AT END OF DRILLING ---
NOTES _____
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		3.75" of HMAC 8.5" of Flexible Base										
		(SC) dark brown, medium dense, dry	SPT		5-6-5 (11)			14	33	17	16	29
		(CL) tan with caliche and limstone cobble, stiff to very stiff, dry	SPT		5-6-4 (10)							
5			SPT		6-7-10 (17)							
10			SPT		8-10-13 (23)							
		(CL) tan with caliche and limstone cobble, very stiff to hard, dry	SPT		11-21-25 (46)			26	69	32	37	57
15												
			SPT		15-33-37 (70)							
20												

Bottom of borehole at 20.0 feet.

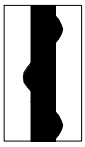
GEOTECH BH COLUMNS - GINT STD US LAB.GDT - 5/19/16 07:52 - L:\EMPLOYEE FILES\HUTSON, COLE\DESKTOP\NEW FOLDER\BELL STREET\BELL STREET LOGS.GPJ

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

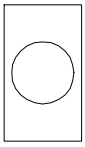
NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

SamIper Graphics Legend


Auger Cuttings

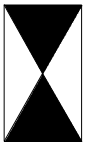

Grab Sample

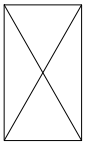

Modified California Sampler


No Recoverey


Rock Core

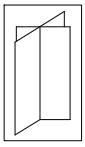

Shelby Tube


Standard Penetration Test


Split Spoon


Texas Cone Penetration


Undisturbed


Vane Shear

July 29, 2016

Mrs. Heather Kiester, P.E., CFM
Project Manager
Freese and Nichols, Inc.
2732 82nd Street, Suite A
Lubbock, Texas 79423

Subject: Addendum 1
Bell Street Geotechnical Engineering Study
San Angelo, Texas

Dear Mrs. Kiester:

A geotechnical engineering study report, CMT16-001, for the Bell Street project between Rio Concho Drive and the Old Ballinger Highway in San Angelo, Texas was submitted to Freese and Nichols, Inc. on June 6th, 2016. An additional option for Roller Compacted Concrete (RCC) was requested after the report was submitted. The following shall be considered in conjunction with the original report.

The pavement thickness calculations were performed using the following parameters that were developed based on traffic data provided by Freese and Nichols, Inc., and the procedures outlined by the American Association of State Highway and Transportation Officials (AASHTO). Based on the provided traffic data, the following ESAL's (Table 7.1) are considered for our pavement recommendations.

Table 7.1 – Pavement Design Loading

Location	Unit Type	Type of Pavement	[1]ESAL
Bell Street (Between Rio Concho Drive and US 67)	Mixed Traffic (Trash/Delivery Trucks and Light Duty AUTO's)	Heavy-Duty	12,950,741
Bell Street (Between US 67 and Old Ballinger Highway)	Mixed Traffic (Trash/Delivery Trucks and Light Duty AUTO's)	Heavy-Duty	8,511,086

(1) -Equivalent Single Axle Load (ESAL) for a 20 year design life.

When appropriate, the item listed in the parenthesis at the end of each bullet item refers to the source of the value.

- 20 year Design Life
- 80% Reliability (assumed, AASHTO)
- 0.35 Overall Deviation for rigid (AASHTO)
- 4,000 psi compressive strength at 28 days (assumed)
- 3,604,997 psi Concrete Elasticity Modulus (extrapolated from compressive strength)
- 3.8 and 4.1 Load Transfer Coefficient (based on edge support, AASHTO)
- 130 psi.in Modulus of Subgrade Reaction (based on assumed CBR of 9)
- Drainage Coefficient = 1.0 (assumed, AASHTO)
- 4.5 Initial Serviceability for rigid (AASHTO)
- 2.0 Terminal Serviceability (AASHTO)

Based on our analysis, we recommend that the following pavement sections (Table 7.2) be considered for the construction of the proposed street with RCC. The proposed pavement sections will provide adequate support for the design traffic as indicated in aforementioned Table 7.1.

Table 7.2 – Bell Street Recommended RCC Pavement Thicknesses

Pavement Type/Location	RCC Section
Heavy Duty / Rio Concho Drive to US 67	12.0 Inches of Roller Compacted Concrete 12.0 Inches Compacted Subgrade
Heavy Duty / US 67 to Old Ballinger Highway	11.0 Inches of Roller Compacted Concrete 12.0 Inches Compacted Subgrade

The recommended pavement section is intended to provide an adequate thickness of structural materials, such that wheel loads are distributed over a larger area. The pavement may be adequate from a structural standpoint, yet still experience cracking and deformation due to soil movements below the section. Therefore, moisture changes in the subgrade should be prevented. The pavement and adjacent areas should be well drained. Proper and regular maintenance should be performed on cracks in the pavement surface to prevent water passing through to the base or sub-base material. Even with these

precautions, some movements and cracking may still occur, which will require periodic maintenance.

It should be noted that the ride quality of roller compacted concrete may be much worse than conventional concrete or HMAC paving. This concern is increased with high volume roadways and speeds over 30 mph such as Bell Street. A specialty contractor should be consulted for this type of pavement with demonstrated knowledge and experience in RCC. The ride quality should be measured in accordance with TxDOT Item 585, "Ride Quality for Pavement Surfaces," Surface Test Type B. Diamond grinding is common for RCC and should be considered as a bid item if this option is chosen.

The following material specifications should be considered for the additional pavement options provided in this addendum.

7.2 PAVEMENT MATERIAL SPECIFICATIONS

Roller Compacted Concrete – TxDOT Special Specification 3016. Multiple lifts may be required.

The subgrade should be prepared in accordance with Section 6 Earthwork Recommendations of the original report.

This is an addendum to the original report and all recommendations provided in the original report still hold true. This addendum shall only be used in conjunction with the original report and shall not be reproduced, except in full, without written permission from CMT Engineering, Inc.

Sincerely,

STATE OF TEXAS
COLE T. HUTSON
118779
LICENSED
PROFESSIONAL ENGINEER
7/29/16

Cole Hutson, P.E.
Project Manager
CMT Engineering, Inc.
Texas Registered Engineering Firm 13112